

FARM MANAGEMENT UNDER UNCERTAINTY:
IMPLICATIONS FOR BEEF CATTLE PRODUCTION

BY

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This dissertation is dedicated

to my children,

Zacharia and Nathaniel,

my wife, Ann,

and to the future.

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FARM MANAGEMENT UNDER UNCERTAINTY:
IMPLICATIONS FOR BEEF CATTLE PRODUCTION

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An analysis of a typical crop and livestock farm in North Florida is presented. The analysis incorporated the potential competition and complementarity among crop and beef cattle enterprises. A Target MOTAD model was developed to account for risk in the decision framework. Hierarchical decision models were used to support and/or specify the MOTAD model specification.

The results indicated that when income risk was ignored peanuts, watermelon, and stocker cattle were the only enterprises included in the optimal solution. When income risk was heavily weighed, the optimal solution included peanuts, watermelon, stocker cattle, cow-calf, and irrigated soybeans. The results suggested that the persistence of cow-calf production may be explained as a stabilizer of income.

CHAPTER I INTRODUCTION

Beef Production in the Southeastern United States

Beef production is economically important to the Southeast region of the United States and is widespread throughout that region of the country. According to the 1978 Census of Agriculture, only one county in the states of Alabama, Florida, Georgia, Mississippi, North Carolina and South Carolina had no beef cattle. The same information held true for the 1982 Census of Agriculture. Despite this situation recent analyses have demonstrated that beef production is unprofitable (Carpenter et al., 1979; Schupp et al., 1979, Wise and Saunders, 1977). One group of authors (Musser et al., 1975) stated that beef production in the Georgia Piedmont could only be explained in terms of utility maximization rather than income maximization or other financial well-being. A similar situation has also been described in Arizona (Smith and Martin, 1972). The purpose of this dissertation is to determine whether the same is true for Florida, and if so, to try to determine why beef cattle are produced in North Florida.

There are several stages to beef production in the United States. The first stage is the cow-calf operation. In this phase a brood cow produces a weaned calf. Weaning occurs at various ages (Three to nine months) and various weights (350 pounds to 700 pounds) depending upon cow and calf management practices and geographic location. Sometimes the weanling calf then goes through a conditioning stage in

preparation for the second major stage, backgrounding. Usually, the calf directly enters into the backgrounding program. A calf in a backgrounding program is called a stocker calf. Backgrounding is a forage-based feeding system. Next the feeder calf is finished, usually on grain-based rations in a feedlot, and then slaughtered.

There is a degree of geographic specialization in the beef subsector. Generally, the Southeast produces calves and backgrounding and finishing occur in the northern and southern Plains states. Florida is not an exception to this pattern.

Beef Cattle Production in Jefferson County, Florida

On January 1, 1984, Florida had an estimated 1,220,000 beef cows (Florida Crop and Livestock Reporting Service, 1984), a number exceeded by only eight states. During 1983, approximately 1,100,000 calves (including dairy) were born in Florida (Florida Crop and Livestock Reporting Service, 1984). Of these, approximately 231,000 were kept as cow replacements; 465,000 weighed less than 500 pounds and were still in the state; only 91,000 (about 8%) weighed over 500 pounds and were still in Florida. Thus, as in the rest of the Southeast, cow-calf operations predominate other beef cattle enterprises in Florida.

Of the total of 391,066 (Table 1.1) steers, steer calves, bulls and bull calves that were reported for Florida in the 1978 census of agriculture (U.S. Department of Commerce, 1980), 71,000 were reported in the 22 county area stretching from Dixie, Lafayette, Suwannee and Hamilton Counties in the east to Escambia County in the west (Figure

Table 1.1. Number of steers, steer calves, bulls and bull calves
in the Florida panhandle

County	Rank	Steers, Steer Calves Bulls and Bull Calves	Percent of Panhandle
(Head)			
Jackson	1	10,912	15.3
Jefferson	2	10,354	14.6
Suwannee	3	8,017	11.3
Madison	4	5,973	8.4
Walton	5	5,173	7.3
Gadsden	6	4,719	6.6
Holmes	7	4,652	6.5
Leon	8	2,996	4.2
Washington	9	2,971	4.2
Okaloosa	10	2,528	3.6
Santa Rosa	11	2,203	3.1
Escambia	12	2,047	2.9
LaFayette	13	1,962	2.8
Hamilton	14	1,860	2.6
Taylor	15	1,205	1.7
Calhoun	16	1,198	1.7
Dixie	17	877	1.2
Gulf	18	601	0.8
Wakalla	19	386	0.5
Liberty	20	316	0.4
Bay	21	150	0.2

Source: U.S. Department of Commerce, 1978 Census of Agriculture.

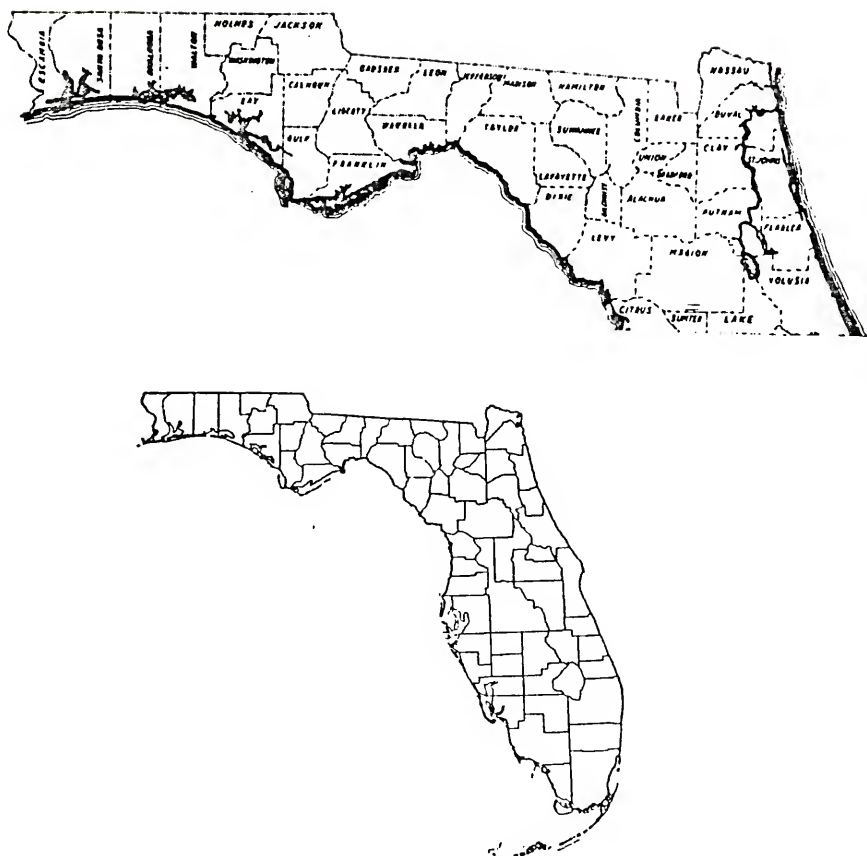


Figure 1.1. Map of north Florida counties.

1.1). (Franklin County data are not specified and are therefore excluded from the total.) Of the animals in the Panhandle, 10,354 (almost 15%) were reported for Jefferson County (the focus of the present study), ranking it second in the Panhandle to Jackson County.

Another way to rate the importance of backgrounding in Jefferson County is to compare the "steers, etc." category to the total number of cattle and calves in the county. A total of 24,760 (including dairy) head were reported for the county in the 1978 census. That is, steers, etc. were 41.8% of the total cattle population in 1978. In dollar terms, sales of \$5,892,000, were reported for cattle and calves, of which 59.2% was for cattle. Logically, the vast majority of these sales would have had to be from steer sales. (For example, in the Waukeena Board Sale of May, 1983, 1,266 steers were sold.) Total cattle and calves sales were approximately 34.4% of the total farm sales.

Review of Previous Studies

Because of the economic importance and widespread geographic distribution of beef production in the South, it has been analyzed in the context of the general farm as well as in an isolated setting. Compared to Census of Agriculture data (Table 1.2), studies based upon optimizing models (Allison and Bell, 1978; Johnson et al., 1979; Wise and Saunders, 1977) indicate that the various phases of beef production are more widespread geographically in the Southeast than is considered to be optimum. This is especially true for the backgrounding of stocker calves. The stocker calf herds are much

Table 1.2. A comparison of cow herd and stocker herd sizes from various studies and sources.^a

State	Cow Herd Size				Stocker Herd Size			
	Large Commercial ^b Farms	Farms Over 100 Acres with over \$25,000 in Sales ^c	Small ^d Farms	All ^c Farms	Large Commercial ^b Farms	Farms Over 100 Acres with over \$25,000 in Sales ^c	Small ^d Farms	All ^c Farms
Alabama	24	65	8	51	37	33	28	28
Georgia	4	52	0	44	307	31	73	26
Kentucky	10	35	0	80	271	24	11	22
Louisiana	19	76	6	65	416	30	130	23
North Carolina	21	28	6	21	0	15	4	13
South Carolina	85	39	NA	35	64	24	NA	21
Tennessee	13	40	0	33	89	22	0	18
Virginia	100	41	50	36	1016	31	967	26
Average	35	45	16	37	275	26	202	22

^aThe category for the Census of Agriculture data used is "steers, steer calves, bulls and bull calves."

^bSource: Wise and Saunders, 1977.

^cSource: 1974 Census of Agriculture.

^dSource: Allison and Bell, 1978.

smaller and the cow herds are appreciably larger than the studies demonstrate they ought to be.

Accounting and Cost Considerations

Beef production in Florida persists even though it can be characterized as group of low profit enterprises (Allison, 1981). Studies conducted in Florida and neighboring states (Georgia Cooperative Extension Service, 1982; Ross et al., 1983; Simpson et al., 1982; Kunkle et al., 1984) have demonstrated losses in cow-calf and stocker operations. In comparison it was found in a recent study (Zimet et al., 1984) that producers in Jefferson County, Florida, believe that they generally break even and that they earn a profit once every three to five years. This finding implies that, at least from the point of view of the producer, the studies tend to overestimate costs. Sources of this over-estimation include

1. over allocation of indirect and overhead costs, such as machinery and land;
2. over-estimation of input levels, such as fertilizer and feed; and
3. over-estimation and over-allocation of labor.

The critical aspects of the allocation/estimation of land and labor are discussed later in this dissertation (Chapter IV). Beef production can be viewed in many cases as a productive, often risky, way to utilize residual and/or marginal land and residual labor. More specifically, when beef production fits into the entire farm operation so that it does not compete with crops (the primary set of

enterprises) for land and labor, the producer will not necessarily allocate all the associated costs to the beef enterprise. For the cow-calf enterprise (which has weaned calves as its primary product), these costs are a higher proportion than they are for the stocker operation (Simpson et al., 1982) which starts with weanlings and sells feeder calves. This logic also helps to explain why, once the decision to more fully utilize resources via a beef herd is made, some people have cow herds and in addition have backgrounding programs and others do not. Thus, for some, the backgrounding operation adds flexibility to the use of resources. For others, backgrounding operations compete for those resources. Therefore, cow-calf operations and stocker operations can be viewed as being either competitive or complimentary for the use of farm resources.

Land can be viewed as a speculative investment as well as a productive resource. Land ownership, however, is not cost-free. Property taxes must be paid, although using the land for agricultural purposes reduces the property tax burden. In addition, payments made to purchase productive resources are deductible business expenses for federal income tax. Thus, for the speculator, a "forgiving" enterprise such as a beef operation (Hewitt and Holt, 1983) has certain tax advantages. A cow-calf enterprise also has a tax advantage over a stocker operation in that the brood cows can be viewed as long term capital. Thus profits resulting from their sale are taxed as long term capital gains. These considerations must be balanced against the actual cost of the purchase as well as the anticipated rate of land appreciation. Thus, in an area where real land values increase slowly, speculation would not be too prominent.

Decision Making and Methods of Analysis

Given the wide occurrence of beef production, the studies which indicate that it is not profitable, and the perception by producers that it is only marginally profitable (Smith and Martin, 1972; Zimet et al., 1984), it can be inferred that the decision by the producer to manage a beef operation is complex. Some of the non-technical considerations encountered in this decision are relevant to the specification of models that seek to analyze beef production. There are various ways to analyze resource allocations in a framework that includes risk. Prominent among these methods are various types of mathematical programming and stochastic efficiency or dominance. A method that has been recently developed by Tauer is Target MOTAD (Tauer, 1983). Target MOTAD combines the computational ease of linear programming with the concepts of second degree stochastic dominance.

Stochastic Dominance

A method developed to deal with risk is stochastic dominance (henceforth referred to as SD). In first degree SD (henceforth referred to as FSD), the first moment about the origin of net returns (a random variable) is used to determine whether a discrete set of inputs and/or outputs is preferred over another discrete set. When one set has an income equal to that of the other set but with a lower cumulative density at a minimum of one point it is to be preferred. Farm plan F dominates plan G in the sense of FSD if $F_1(Y) \leq G_1(Y)$ for all possible income levels, where $F_1(Y)$ and $G_1(Y)$ are the cumulative probability distributions of the probability density functions $f(y)$

and $g(y)$, respectively, and y is income. Second degree stochastic dominance (henceforth referred to as SSD) is less restrictive than FSD. It requires that the variance (the moment about the mean or second moment) be at least as small as the variance from the other discrete set of inputs and/or outputs. There is the additional requirement that the variance derived from the first discrete group be smaller than that derived from the second group in at least one situation.

Under stochastic dominance a functional form of the utility function is not assumed. In terms of income and utility, FSD is based upon the assumption that more income is preferred to less. SSD assumes there is decreasing and positive marginal utility of income. Thus SSD applies to people who are risk averse.

Similar to FSD, SSD is represented by cumulative probability distributions. Farm plan F is more efficient in terms of second degree stochastic efficiency than farm plan G if $F_2(R) \leq G_2(R)$ for all possible income levels and the strict inequality holds at least once. $F_2(R)$ is the integral of the cumulative probability function F_1 :

$$F_2(R) = \int_a^R F_1(y) dy$$

and $G_2(R)$ is the cumulative density function of G_1 :

$$G_2(R) = \int_a^R G_1(y) dy.$$

Anderson et al. describe the difficulty with using SD criteria,

In decision problems involving continuous decision variables, it would be convenient to conduct efficiency analysis in a manner broadly analagous to those of continuous response analysis . . . unfortunately this is impossible because . . . the analysis of stochastic efficiency is intrinsically a discrete affair involving pairwise comparisons. (1977, p. 302)

They go on to state that the difficulty can be overcome by the application of Monte Carlo programming. By using the vegetable production problem used by Hazell in 1971, Anderson et al. (1977) were able to compare SD and E-V efficient sets.

In order to obtain a set of 20 SD efficient farm plans they had to analyze 48 plans which were obtained via Monte Carlo programming. This particular problem had only four production alternatives. Problems for the general farms of north Florida would require more alternatives and thus many more simulations. This makes the SD method unattractive as a tool to analyze whole-farm plans.

Mathematical Programming

In contrast, mathematical programming models are prescriptive decision tools that respond to the question, "given the technical requirements of potential alternative actions, the resource base, and certain non-technical requirements, what product mix or resource allocation will most efficiently obtain the specified goal or objective?" By their nature, these models are more applicable to the analysis of firm rather than aggregate problems.

Quadratic Programming, MOTAD and Risk

Quadratic programming (henceforth referred to as QP) is a programming method which seeks to optimize a quadratic objective function subject to a set of linear constraints. Income variation can be viewed as a measure of risk of an economic enterprise. Variance, of total net returns, is a quadratic function. Thus, QP can be used to minimize risk subject to a set of linear technical and non-technical constraints. Frequently income requirements are included in the non-technical constraint subset. When parametric programming is performed, an expected income-variance (henceforth referred to as E-V) frontier is constructed. This frontier defines the trade-off between risk (as defined by variance of income) and income. A standard mathematical representation of E-V using QP is

$$\text{Minimize } Z = \sum_{k=1}^n \sum_{j=1}^n x_k x_j s_{kj}$$

subject to

$$\begin{aligned} \sum_{j=1}^n a_{kj} x_j &\leq b_i & i = 1, \dots, m \\ \sum_{j=1}^n f_j x_j &= \lambda \end{aligned}$$

where $x_j \geq 0 \quad j = 1, \dots, n$

x_j is the level of the j th activity;

s_{kj} is the covariance of net return between k and j ;

a_{ij} is the use of resource i by activity j ;

b_i is the amount available of resource i ;

f_j is the expected net return from activity j ;

λ is a parameter to be varied from 0 upward.

The theoretical properties of E-V analysis (which include a quadratic utility function) are retained only when net returns are normally distributed or when enough observations are used so that the central limit theorem can be applied (Anderson et al., 1977, p. 197).

An alternative to EV analysis is MOTAD, the minimization of total absolute deviations, developed by Hazell (1971). The analysis upon the MOTAD model is expected income-absolute deviation of income (henceforth referred to as E-A) analysis. The MOTAD model is fully linear and thus can use the linear programming algorithm.

There is one other major difference between E-V and E-A analysis. In E-V analysis, the semi-variances caused by positive and negative deviations from the mean are weighted equally. Expected income-absolute deviation analysis permits differential weighting of positive and negative deviations. Hazell compares this aspect of the E-V model and the E-A model as follows:

. . . there may be no a priori reason to assume that he (the producer) attaches any disutility to positive income deviations so that using an E-V criterion may lead to unnecessarily conservative farm plans. Markowitz suggested that when total gross margins cannot be expected to be symmetrically distributed, an expected return-negative semi-variance criterion might provide a better approximation of an individual's utility function. . . . Such a model can be solved only through Monte Carlo techniques . . . (1971, p. 60)

Hazell gives the following mathematical representation of the MOTAD model:

$$\begin{aligned}
& \text{Minimize } A = \sum_{h=1}^s (y_h^+ + y_h^-) \\
& \text{subject to } \sum_{j=1}^n (c_{hj} - f_j)x_j - y_h^+ + y_h^- = 0 \\
& \quad (h = 1, \dots, s) \\
& \text{and } \sum_{j=1}^n f_j x_j = \lambda \\
& \quad \sum_{j=1}^n a_{ij} x_j \leq b_i \quad (i = 1, \dots, m) \\
& \quad x_j, y_h^+, y_h^- \geq 0 \quad (\text{for all } h, j). \\
& \quad \quad \quad (1971, \text{ p. } 57)
\end{aligned}$$

where

A = total absolute income deviation;

y_h^+ = the positive deviation from the mean in period h

y_h^- = absolute value of the negative deviation in period h ;

f_j = expected return of the j^{th} activity, and

x_j is the level of the j^{th} activity;

c_{hj} = the return per unit of the j^{th} activity at the h^{th} observation, and

λ = a scalar;

a_{ij} = the per unit resource requirement of resource i by activity j , and

b_i = availability of resource i .

Target MOTAD

Tauer developed a modification of the MOTAD model which is "computationally efficient and generates solutions meeting the second-degree stochastic dominance test" (1983, p. 606). He termed the model Target MOTAD. The model maximizes expected income subject to technical and income requirement constraints. (No functional form of the utility function is assumed.) The negative deviations from the

target level of net return of the firm (Y_h) are weighted according to their probability of occurring (P_h). In most empirical applications, P_h is set equal to $1/s$.

$$\begin{aligned} \text{Max } E(z) &= \sum_{j=1}^n f_j x_j \\ \sum_{j=1}^n a_{ij} x_j &\leq b_i & i = 1, \dots, m \\ \sum_{j=1}^n c_{hj} x_j + Y_h &\geq T_h & h = 1, \dots, s \\ \sum_{h=1}^s P_h Y_h &= \lambda \\ x_j ; Y_h &\geq 0, \end{aligned}$$

where $E(z)$ is the expected return of the plan; f_j is the expected return of enterprise j and x_j is the level of enterprise j ; c_{hj} is the unit return of enterprise j in period h ; a_{ij} is the technical requirement of enterprise j for resource i and b_i is the available level of resource i ; T_h is the target return level for the firm in period h ; λ is a constant that is parametrized from M to 0 and s is the number of states of nature or observations. A Target MOTAD model of a general, crop-beef, farm in Jefferson County, Florida, is developed and analyzed in this dissertation.

Hierarchical Decision Models

Mathematical programming models yield direct answers to specified management problems. They are not, however, directly related to the

decision process of the individual farmer. The specification of objectives, production alternatives, and constraints are usually exogenous to the programming model. The development and analysis of hierarchical decision models (henceforth referred to as HDMs) permit these subjective considerations to be elicited from the decision makers themselves and analyzed within a formal methodological framework. Mukhopahyay (1984) made this argument relative to decision process models and statistical approaches. Her argument is broadened here to include mathematical programming models as well. She stated that by focusing

. . . on identifying alternative choices, and then specifying the set of conditions leading to each alternative outcome, we come to understand the process which generates observable behavior. In short, we not only discover the factors which enter into choices; we can specify the inter-relationships between factors (1984, p. 241)

The complimentary nature of mathematical programming models and HDMs is explained in Chapter III. The computability should prove useful to analyze the problem understudy in this dissertation. The apparent inability of standard economic analyses to explain the persistence and geographical distribution of beef production indicate the need to account for other, more subjective, information when specifying programming models.

Problem Statement

In recent years economists have had difficulty in justifying beef production with the application of the formal tools of economic analysis. Because rational economic behavior on the part of the producer is usually assumed, this difficulty leads to an apparent

paradox when compared with the widespread persistence of beef production, particularly in the Southeast. Florida, especially the Panhandle, experiences the same situation as the Southeast as a whole.

For the Southeast, the apparent unprofitability of beef production has been documented (Carpenter et al., 1979; Schupp et al., 1979; Wise and Saunders, 1977). Musser et al. (1975) have characterized cow-calf production in the Georgia Piedmont as "conspicuous production" because it is difficult to explain in purely financial terms why people continue to produce beef. They argue that the satisfaction and prestige embodied in a cow-calf operation must be taken into account when trying to explain the occurrence of beef production. Others have found this to be true for the West, particularly the Southwestern United States [see Smith and Martin (1972) for a bibliography].

Objectives

The overall objective of this dissertation is to help explain why north Florida farmers choose to produce beef. In order to achieve this goal several specific objectives or tasks have been accomplished. They are

1. review previous beef production and whole-farm planning/optimization models;
2. describe the use of hierarchical decision models (HDMs) and explain how they can be used to predict the decision of a producer to have a beef operation (their use as it relates to the type of beef operation is also explained);

3. describe several types of beef production operations in north Florida; and
4. use optimization methods in conjunction with HDMS to determine optimal size herds, calving and weaning dates, and product mix for a specific producer.

Procedure

The first objective entails a literature review of methods of farm planning/optimizing models. The emphasis is on work that has been done in the Southeast. However, a study from Washington is also included. The review is done in order to describe how various types of models have been used. Ways to incorporate some of the aspects of either technique or general approach of the previous studies into the present study were also sought.

Given that neither income nor income tax breaks (Smith and Martin, 1972; Bostwick, 1969) alone help to clarify the question of why some people raise beef, other aspects should be investigated and analyzed. One approach is to gain further insight into the decision framework of the producer so that the decisions made do not seem illogical or capricious. The second objective entails the application of HDMS to the problem of delineating the structure of producer decision making.

An analysis of the decision framework of the (beef) producer suggests that a producer confronts a series of decisions regarding his beef operations. The series:

1. the decision whether or not row crops should be produced;

2. the decision of what to do with the land that is not used for row crop production (for whatever reason), and if beef is to be produced on this land;
3. the decision of what type of beef operation (cow-calf as compared to stocker, for example) to have.

The analysis describes the decision system as perceived by producers and it is possible to reshape some HDMs (depending on the nature of the criteria) into specified constraints of mathematical programming models. An HDM per se, however, yields a qualitative (yes/no) outcome.

All of the optimizing models developed include information either directly from the HDMs or obtained from interviews used to construct the decision models. This information is used to help define the economic, decision, and production system as perceived by producers. The optimizing models are used to help address the following issues for specific producers:

1. What is the optimum sales weight (range) for calves?
2. Is it better to raise calves born by cows owned by the producer to feedlot ready weights (about 700 pounds or more) or is it better to purchase conditioned weanlings (250-400 pounds) and raise them to feedlot ready weights?

These questions are addressed in a mixed (crop and livestock) farm model. (The beef operations are not analyzed in isolation.)

To accomplish the overall goal and these objectives, beef production and beef producers of Jefferson County, Florida (Figure 1), were analyzed. Jefferson County was selected because a variety of

operation types (variations of both cow-calf and stocker operations) occur there, and because the County Extension Director was supportive of the effort.

CHAPTER II BEEF CATTLE AND OPTIMIZING MODELS

A method that could be used to analyze a given situation at the farm level is the enterprise budget. Such budgets have been used by Ross et al. (1983), Simpson et al. (1982), and Wise (1974) to describe resource requirements for producing specific commodities at specific locations with specific input levels and technology. These analyses, however, indicate little regarding optimal resource allocation. A mathematical programming model of a typical farm is an appropriate model to solve the resource allocation problem.

Previous Studies

There have been previous attempts--some successful, others not successful--to include beef production in general farm models. Several studies that occurred in the South are the focus of the review presented here. However, a study from the Columbia River Basin, Washington, is included because of the method of analysis that was used. In recent times (since about 1975), stocker operations have not entered into optimal solutions with realistic herd sizes while cow-calf operations have not been considered because of low or negative net returns.

A study by Musser et al. (1975) analyzed this phenomenon, calling it conspicuous production, analogous to the idea of conspicuous consumption developed by Thorstein Veblen. The authors stated, "past studies on maximum profit farm organization have indicated that

beef cows are not competitive with other enterprises" (1975, p. 89). Their analysis of a typical farm (using cost data developed by Wise) was based upon a utility function subject to an implicit production function and a profit function. Using this technique they developed a production frontier for beef cows and profits. The resulting profit maximizing cow herd size ranged from zero to 20 cows for a general crop and livestock farm. This number is well below observed herd sizes (Table 1.2).

Wise and Saunders (1977) performed a linear programming analysis of large commercial farms in the South. Beef and feed farms as well as general farms were included in the analysis. The objective was to maximize net returns to the labor and management of an operator of a typical farm. Twenty-three subregions were included in the study. In the optimum solutions for the general farms, 19 of the subregions included brood cow herds. The average size for the cow herd was 33 head (Table 1.2). The range, however, was from 134 cows to four cows. About half of the 23 calves from these cows were fed to slaughter weights, one-quarter were kept for backgrounding and one-quarter were sold at weaning. Backgrounding purchased weanlings for 150 days predominated the beef enterprises. The average herd size was 295 head, but only 14 of the subregions had this type of operation.

When compared to the situation presented in the 1974 and the 1978 Census of Agriculture, several things become apparent. First, backgrounding and cow-calf herds occur in all regions of the South. Secondly, under favorable beef prices in the pre-1975 period, farms that had over \$2,500 in gross sales and operated on at least 100

acres, had an average cow herd size of about 45 head, almost one-third greater than optimum. A similar analysis, based upon a similar price structure, was conducted for small farms by Allison and Bell (1978). The optima obtained in that study were much closer to the 1974 Census of Agriculture data for all farms (Table 1.2).

The optima for purchased calves (Table 1.2) are much larger than the observed number. This could be caused by two factors--the relatively favorable 1969 beef prices used in both studies (Table 2.1) and that neither analysis took risk into account. The latter point could be critical as the estimated variance of net returns per head to land and management for a north Florida winter backgrounding program during the 1960/61-1975/76 period (Ross et al., 1983) was \$753.24. Furthermore, of these 16 years, four years had negative returns. Thus, even in a favorable period, the relatively high profit stocker operation lost money 25% of the time. (This can be compared to the six year 1976/77-1981/82 period which had negative net returns for three years).

Johnson et al. (1979) conducted a study similar to those of Wise and Saunders (1977) and Allison and Bell (1978). Johnson et al. (1979), however, concentrated on the Georgia Coastal Plain as compared to the latter two which considered the entire Southeast. Another critical difference is that Johnson et al. (1979) used 1976 prices. These prices were much less favorable for beef than they were in 1969 (Table 2.1). As indicated in Table 2.1, relative beef prices decreased by about 50% when compared to corn, soybeans, tobacco, peanuts, and feeder hogs. Unfortunately, Johnson et al. (1979) did not

Table 2.1. Relative feeder-calf prices used in other studies.

	Authors		
	Wise and Saunders, Allison and Bell	Johnson et al.	Prevatt
Year of Prices	1969	1976	1973-1977 average
Price of choice, 250-500 pound, feeder steers (\$/cwt)	34.00	36.10	32.91
Price ratios:			
Steer: Corn ^a	32.4	13.8	12.9
Steers: Soybean ^a	15.5	6.5	5.5
Steers: Peanuts ^b	340.0	180.5	172.5
Steers: Tobacco ^b	68.0	32.8	32.1
Steers: Feeder Hogs ^c	0.9	0.5	NA

^aBased upon per bushel corn or soybean prices.

^bBased upon per pound peanut or tobacco prices.

^cBased upon hog price per hundred weight.

Source: Wise and Saunders (1977), Allison and Bell (1978), Johnson et al. (1979), Prevatt (1979).

include a cow-calf enterprise among the alternatives of the linear programming model they developed. They differentiated between small, medium, large and extra large farms as well as full- and part-time small farm operators. In the Johnson et al. (1979) analysis, only medium-sized farms had some optimum solutions with small stocker operations. Because the price of beef increased dramatically from 1976 to 1978 (from \$36.10 to \$61.45 per hundred weight for 400 to 500 pound feeder calves), the analysis was also conducted with 1978 beef prices. However, "these increased cattle prices had very little effect on farm organization on all farm sizes. The feeder calf on winter grazing operation entered the solution on the medium-size farm, but the organization was not different from the base solution" (Johnson et al., 1979, p. 26).

It can be argued that for an on-going beef operation one year is similar to any other year. It also can be argued that a cow-calf operation and, because of permanent pasture development, to a lesser extent a stocker operation are multi-period, dynamic enterprises and should be modeled as such. Prevatt (1979) did so using 1973-1977 as the years of analysis. This study concentrated on the technical/nutritional requirements of a beef cow-calf herd. The objective was to maximize net returns to land, labor, management and fixed cow herd and several cropping alternatives. This type of objective exaggerates the concerns related to over estimation of costs expressed in Chapter I of this dissertation. More specifically, because a cow herd is a capital investment not all fixed costs should

be excluded from the cost calculations. Furthermore, three of the five years in which the study takes place have favorable beef prices. [The net return ratio beef:crops decreased from 0.7 in 1973 to 0.6 in 1977 (Prevatt, 1979, p. 53, 58).] When added to the land constraint which limits one-half the available land to permanent pasture production, and stringent culling criteria, beef production is almost inevitable. As a result, a cow herd of approximately 100 is included in the optimum solution.

These general farm models have not included risk considerations. As implied above, if variance of net returns is used as the measure of risk, the consideration of risk can be critical because of observed large variances of net returns. Thomas et al. (1972) incorporated constrained risk minimization into a general farm model of a typical farm in the Columbia Basin of Washington.

The model developed by Thomas et al. (1972) used separable programming to approximate the variance-covariance of income function (based upon 1950-1969 data) of five crop and eight livestock enterprises. The objective was to maximize expected income "subject to appropriate physical and financial constraints and an upper bound on income variance" (Thomas et al., 1972, p. 262). By use of appropriate constraints, acceptable levels of risk were specified as were acceptable levels of income. An approximation of variance was developed by dividing variance into positive and negative semi-variance. The approximation was then simulated by a "piecewise linear approximation" (Thomas et al., 1972, p. 262).

Cow-calf and cow-yearling enterprises were included among the six beef enterprises. Other beef enterprises included were spring/summer backgrounding, fall/winter backgrounding and two finishing operations. Only the two finishing operations and one of the backgrounding operations entered the optimal solution. The number of head remained stable as the acceptable level of variance was changed. It is assumed that the cattle for these post-weaning programs are available from another region of the state or country. The specific value of the study to the panhandle of Florida is limited because of differences in product mix potentials, harvest period and therefore price of commodities, and the economic feasibility of finishing cattle.

There is another difficulty with this study. Separable programming was used to develop an estimate of the variance-covariance matrix in order to generate efficient or optimum plans that "minimize variance for a given level of expected returns" (Thomas et al., 1972, p. 260). The major problem associated with a variance-covariance based analysis is that both positive and negative deviations are weighted equally. Obviously, a farmer would welcome positive income deviations and thus these deviations should receive less weight than negative deviations.

An Application of MOTAD to a Beef Production Problem

Angirasa et al. (1981) utilized the E-A criterion to study production of a typical East Texas cow-calf operator. One of their objectives was "to develop expected profit-risk efficient sets" (1981, p. 89). They analyzed three types of beef production/sales

alternatives--sales of weanlings, feeder calves, and forage-finished cattle. A simulation model was used for the feed requirements aspect of the model and various forage and feed combinations (for example, coastal bermudagrass overseeded with rye-ryegrass, coastal bermudagrass alone, and common bermudagrass overseeded with crimson clover-ryegrass are included as production alternatives). Prices used to construct the revenue deviation submatrix were from the period 1958-1977.

Part of the analysis included certainty of returns (i.e., a straightforward linear programming problem). Under these conditions the standard cow-calf operation predominated. When the MOTAD model was used, however, backgrounding increased when the risk constraint was made more restrictive. (This is not surprising since backgrounding calves that were not purchased is a form of hedging as sale weight and even price, up to a certain point, can be controlled by the seller or producer.) In terms of the Florida panhandle this analysis by Angirasa et al. (1981) should be improved upon. First, only cow-based beef enterprises are considered. This situation is not common in the panhandle which has many types of general farms, but few commercial farms which produce only beef. In addition the study assumed a large farm, with a large resource base and a high level of management. Thus, little direct light is shed upon the issue of why people raise beef in the Southeast. As stated by the authors,

a word of caution is also warranted concerning the empirical findings of this study. These results are based upon the analysis of a large farm, high level of management, and Hereford-type cattle at one location only. Given its limited resources, a small farm may or may not find these management

practices equally profitable Any
extrapolation from the results of this study
warrants consideration of the model and its
assumptions. (Angirasa et al., 1981, p. 9)

CHAPTER III

HIERARCHICAL DECISION MODELS AND FARM PLANNING MODELS

Some social scientists, including agricultural economists, have determined that simplistic optimizing models do not always explain and/or predict adequately the behavior of the producers (for example, Barlett, 1980; Chibnik, 1980; Day and Cigno, 1978; Gladwin, 1975; Johnson, 1980; Smith and Martin, 1972; Willis and Perlack, 1980). There are several themes that are found in the literature related to decision making that suggest explanations as to the inadequacy, with respect to predicting producer behavior, of the simple optimizing models. Some scientists claim that decision making is too complex to be modeled with no subjective criteria and/or constraints. Among these authors are those who offer ways to improve upon the solution algorithm by generalizing it while others suggest that other methodologies would be more appropriate. In the former group are those who include risk in their production models (Dillon and Anderson, 1971), multiple objective functions (Candler and Boehlje, 1971), or constrain optimal outcomes to be consistent with previous behavior or decisions (Day and Cigno, 1978).

Those who call for different methodologies or solution algorithms of a different type have found the usual algorithm applied by economists to be empirically inaccurate or unusable. Johnson states, for example,

I will argue that the formal model is by itself virtually uninterpretable without reference to an ethnographic context that can be provided only by participant observation over a long term field research. This is no momentary obstacle . . . but is, rather, an inherent limitation on the extent to which formal models can account for observed outcomes of agricultural decisions. (1980, p. 20)

Gladwin argues that the mental processes assumed by optimizing models are too complicated because they ignore decision rules. She states

Most of the currently popular theories, however, suffer from the fact that they do not take into account the simplifying procedures or heuristics that people use in real life to make their decision-making process easier. (1980, p. 45)

Chibnik (1980) notes that models based upon the optimization of a single goal are often inaccurate because of the over-riding importance of the constraints, and the difficulty of determining constraints and specifying a single objective.

Johnson (1980) offers no real alternative to the commonly used optimizing algorithm. Gladwin (1975) and Chibnik (1980) stress the importance of predicting historical choice outcomes. Chibnik states that observed, identifiable, quantitative information (size of household, for example) can be used to predict both qualitative and quantitative decisions. The approach used by Gladwin, termed hierarchical decision models (HDMs), normally yields discrete, qualitative (yes/no; do/do not) results. Before application of HDMs to a standard optimizing algorithm is discussed, HDMs and their use are described more fully.

Hierarchical Decision Models

Decision is the critical word for researchers in this method of analysis. Sen breaks the decision process into four basic steps: "(1) definition of the objective, (2) identification of possible choices, (3) collection of relevant information, and (4) drawing of appropriate inferences" (1977, p. 3). The process by which HDMs are developed and the models themselves help the researcher focus on those four steps from the point of view of the decision-maker. Gladwin et al. state,

researchers . . . can build models of the decision-making process that incorporate farmers' decision criteria and constraints. The models of decision-making are hierarchically ordered on the basis of the characteristic to be maximized, incorporating alternative branches based on the constraints and criteria of the farmers. (1984, p. 33)

The importance of incorporating the perspective of the decision-maker should not be over-looked. As Anderson et al. state,

Some people have been unable to tolerate the sacrifice of "scientific objectivity" inherent in the personal approach. But "objectivity" in science is a myth, in life an impossibility, and in decision-making an irrelevance. (1977, p. 18)

In other words the perception of the situation by the economic agent is critical. What the agent believes to be the most important problems and constraints to overcoming them are important to the analysis of decision-making and the development of programs to assist the group of agents in question. Decision trees, a methodology which lends itself to subjective orientation, were used in the present analysis.

The Development of Decision Trees

A decision tree is a graphic representation of an HDM. It is a flow chart of the decision process. Gladwin (1979) describes the construction of a decision tree as a five step process to be completed after open-ended interviews are used to elicit criteria from the economic agents in their own words. The remaining four steps are

1. Arrange constraints and categories of the agents into a flow chart using the language of the agents.
2. Trace the paths through the charts of the agents originally sampled to create a composite chart in order to test its descriptive accuracy.
3. Develop a more generalized model based upon the original model; and
4. Test the generalized model.

It is the first step, the elicitation of criteria in the words of the economic agents which is critical to the specification of the decision tree model. The other four steps help to assure that the analysis is orderly and the model accurate.

For the present analysis a draft questionnaire was designed only after some time was spent with the producers learning their "language" and gaining an appreciation for their production systems and problems. After some revision of the questionnaire, a somewhat formal, open-ended questionnaire which asked questions about management practices was administered. Thus insight was gained as to how producers make decisions and what they focus on.

Decision Trees for Beef Producers in Jefferson County

Several decisions must be made before a person becomes a beef producer. First, the decision to become a farmer must be made. Second, the use of (potential) crop land must be decided and third a decision regarding the use of land that is not cropped must be made. The latter two decisions were analyzed as was the decision of what type of beef enterprise to operate. Decision trees (Figures 3.1, 3.2, and 3.3) were made of those decisions in order to clarify the decision framework of producers. Many of the criteria that were determined to be important via the decision tree analysis were used to develop the mathematical programming model used in this research. (For a discussion of how to read a decision tree see Appendix A.)

The three HDMs were developed in the same way. The initial step was a set of informal, unstructured interviews with ten Jefferson County beef producers as well as extension workers and employees of the Soil Conservation Service. After discussing certain aspects of those interviews with agronomy, animal science, and extension specialists at the University of Florida, a questionnaire was developed and tested on ten producers. It was revised slightly as a result of the test. Personal interviews were then conducted with 28 current and two former beef producers. The questions were generally open-ended in order to obtain the opinions of producers about various management practices and marketing schemes. In addition, specific, technical questions (about calving rates, fertilizer application rates, and use of pesticides, for example) were also asked. Each interview required from one to two hours to conduct. The survey took

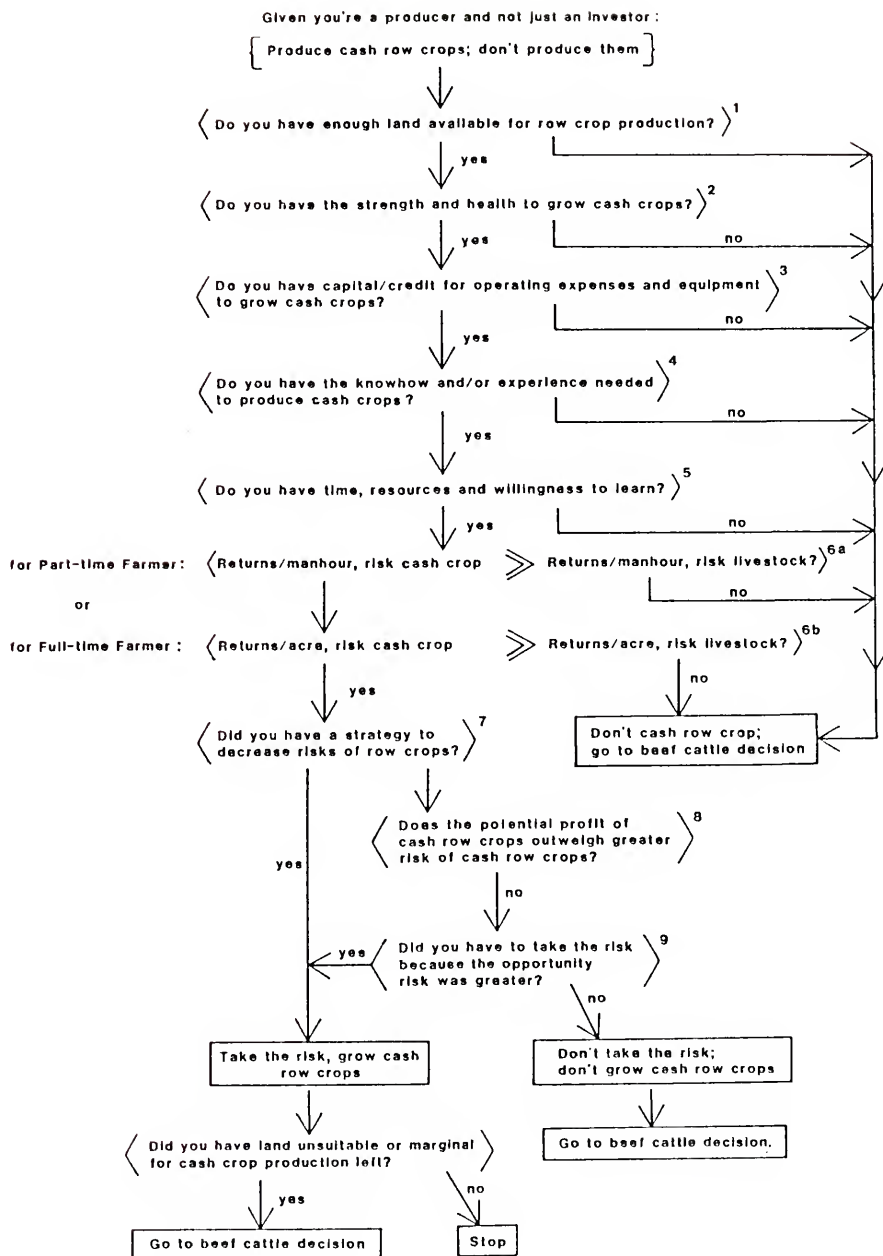
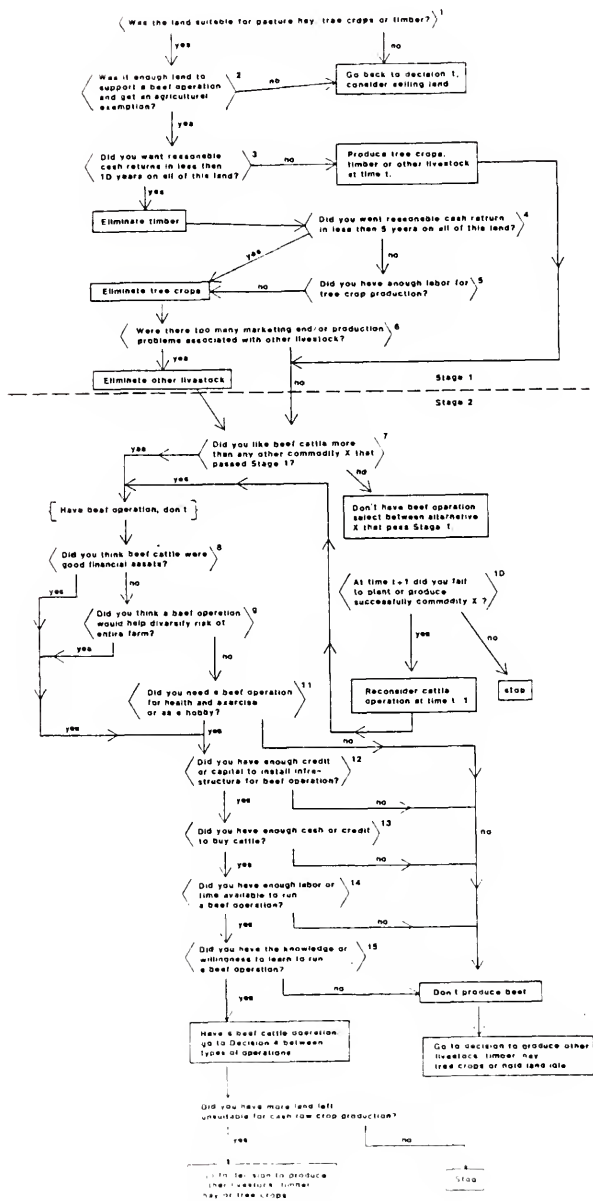


Fig. 3.1. The decision to produce cash row crops.

Fig. 3.2. The land use decision for
land not in commercial
row crop production.

Given the Decision Not to Grow Cash Row Crops on Some Land
Beef Cattle Other Livestock Timber Tree Crops, Hay



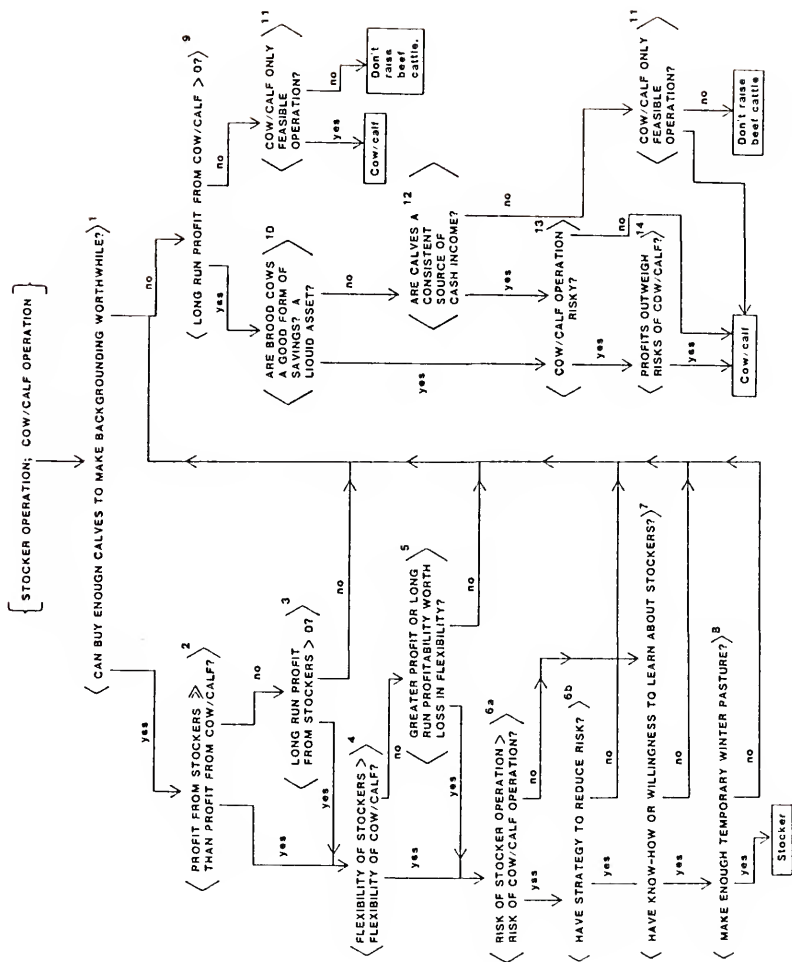


Fig. 3.3. The decision to operate a stocker or a cow-calf operation.

place over a four-month period during the late winter and spring of 1983. As part of the analysis of the data obtained, the HDMS represented by the decision trees displayed in Figures 3.1, 3.2, and 3.3 were developed. The decision trees were tested over a five-month period in early through mid 1984.

The Decision to Grow Cash Crops and the Decision to Have a Beef Cattle Operation

Farms are endowed with different types of land. In very broad terms there is land suitable for commercial row crop production and land that is not. Land might fall into the latter group because of a variety of reasons such as the soil profile and stability, the drainage situation, the topography, or accessibility for machinery. Decisions must be made concerning the use of either type of land before it is put into production.

The decision to grow cash crops

There are several constraints to being able to produce cash crops (Figure 3.1). First the land must be suitable in terms of quantity available and quality for such production (Criterion 1). In addition the human resources in terms of strength (Criterion 2), knowledge (Criterion 4), and time (Criterion 5) must also be available. The availability of capital for equipment as well as for operating expenses is also to be considered (Criterion 3). The potential risks and returns for cash crops compared to those of the major alternative, livestock (Criteria 6A and 6B), need also be taken into account. Finally, in the event that land is still available the producer should

consider other production alternatives (Figure 3.2). This model was tested on 25 producers. It was accurate in 23 cases (92.0%).

The decision to have a beef cattle operation

Beef cattle production is a way to utilize land that is not used for row crops (Figure 3.2). The land, however, must also be suitable for beef production. If it is suitable for beef it would also be suitable for other products (Criterion 1). Criterion 2 through Criterion 4 in Figure 3.2 consider the cash flow horizon of timber and tree crops. Many producers stated that they were not in a position to wait the necessary time to obtain a positive cash flow from their land. Some stated that the time necessary for tree crops to generate a positive cash flow was not too long, but that tree crops required too much labor during the warm season to fit into their farm management scheme (Criterion 5).

Primary among the livestock alternatives to beef are sheep and goats. In north Florida, they face uncertain markets (Criterion 6). Hogs are another livestock alternative to beef. Hogs, however, require a relatively high investment in facilities as well as high nutritional requirements. The nutritional requirements are usually met by farm-grown corn. Thus, there are production difficulties associated with hog production (Criterion 6).

Jefferson County producers stated that they must like any non-row crop alternative they consider (Criterion 7). If beef cattle are preferred then the technical considerations regarding production must be taken into account (Criteria 9 and 12 through 15). Criteria similar to these are discussed below in the section about the cow-calf

versus stocker decision. Criterion 10 primarily considers crop failure. Hobbyists, semi-retirees and retirees are included in the group of potential beef producers via Criterion 11. To test the HDM represented in Figure 3.2, 24 producers were interviewed. The model was accurate in 23 cases (95.8%) for the beef production phase and in 15 cases (62.5%) concerning the other products.

The Cow-Calf Versus Stocker Decision

Coincident with the decision to produce beef cattle is the decision of what type of herd to operate (Figure 3.3). In Florida as in other Southern states, raising stockers is potentially more profitable than owning a cow-calf herd (Ross et al., 1983). Yet, according to the 1978 Census of Agriculture (U.S. Department of Commerce), more producers have cow-calf herds than stocker herds. Obviously, from the point of view of many producers, there are disadvantages and/or constraints to owning a stocker operation. These are represented by the first criterion and the criteria on the left hand path of the tree.

The first criterion is scale of operation, a barrier to entry to backgrounding for producers with limited resources. Scale is important because of the requirements of the feedlot operators. While conducting field research in Jefferson County it was discovered that there were no small stocker herds (under 30 head) and that most were over 100 head. This led to an attempt to analyze the size requirements of a stocker herd. Backgrounding feeder cattle is an intermediate step in the production of high quality beef. It precedes intensive feeding of the animals in a confined feedlot. Presently,

feedlots require lots of approximately 40 uniformly-sized feeder cattle. The broker for the feedlot must assemble such lots for their clients. The brokers seek to do so with minimum effort. A small beef producer may find it impossible to produce 40 (or even the major portion thereof) uniformly-sized cattle. Failure to supply a minimum 25 to 30 head usually results in a price discount, thereby reducing the profitability of the backgrounding operation.

From the point of view of the producer, scale is important because returns per animal are low and marketing costs per animal, especially hauling animals to and from the farm vary inversely with the number of animals. During interviews several farmers claimed that hauling fees with less than half a truckload of animals (i.e., less than 25 to 30 animals) are excessive.

Other important aspects of the decision are the short and long run returns (Criteria 2 and 3 in Figure 3.3) to each type of beef operation. If the producer believes a stocker operation would be less profitable than a cow-calf operation, he should not operate a stocker enterprise. If he believes that it would be more profitable to have a stocker operation for either time horizon, he should then consider the flexibility of the operations (Criterion 4). The relative importance of profit and flexibility (Criterion 5) must also be considered.

The production of high quality winter forage is another critical aspect of backgrounding (Criterion 8). It is through the consistent production of such forage that risk can be reduced and profitability can be increased. The risk of the stocker operation is greater than that of the cow-calf operation because of price fluctuation as well as

dependence upon weight gain--the critical factor in a successful backgrounding program.

There are reasons other than scale, risk, and availability of winter pasture which inhibit or prevent producers from running stocker operations. A producer must know how to run a successful backgrounding program (Criterion 7). Most producers, especially those from a farm background, have a reasonable understanding of animal health and nutrition needs. Producers who originally lack this knowledge can obtain it from a number of sources. Marketing know-how is another matter. There are two marketing aspects related to the management of a stocker herd. First, the right kind of animal must be purchased; and second, the animal must be sold. The former is critical as animals that will gain efficiently are keys to success. The ability to purchase such animals can be described as a learned art that is not just "picked up." Being able to produce an adequate supply of temporary winter pasture (Criterion 8 of Figure 3.3) is also critical. If a producer has a winter backgrounding program he must be able to produce such pasture in a timely fashion in order to obtain good weight gains. Thus the producer must ask himself whether he has enough time, the proper machinery and equipment, and the know-how to plant combinations of cool season forage. If he cannot do so, he should not do winter backgrounding.

As compared to these disadvantages of a stocker operation, however, are the advantages of greater profitability and greater flexibility. The stocker operator can change herd size according to anticipated market conditions and available time and pasture. In comparison, the cow-calf operator invests a good deal of time and

management in the breeding program, trying to develop a brood cow herd that does well under the conditions of the specific farm. He would thus be reluctant to sell-off part of his breeding stock in a bad year in order to decrease herd size. Similarly, increasing herd size in the short run is also more difficult for the cow-calf operator. Finding the "right" brood cows or raising replacement heifers of good quality is a long-run proposition. If a producer has none of the above motivations to run a stocker operation or if he cannot meet the requirements of such an operation, he should not background calves. In Figure 3.3, such producers would pass to the cow-calf branch (right hand side) of the decision tree.

Like the stocker operation, a cow-calf operation has certain advantages and disadvantages. The major disadvantage is that it is less profitable than a stocker operation of sufficient size. In addition, cow-calf operators, more so than stocker operators, justifiably believe that they will lose money for approximately three years while starting up the operation (Zimet et al., 1984). While heifers mature, management experience is gained, and a production system is established, they lose money. In contrast, stocker operations lose money for perhaps two years while managers gain experience and establish a production system. Thus Criteria 3 and 9 ask if the producer believes that such losses can be sustained.

Beef producers in Jefferson County, Florida, believe that cow-calf operations do have some advantages (Zimet et al., 1984). Because brood cows are long-term investments which generate a product (calves), they are viewed as a form of savings (Criterion 10). They can serve as collateral for loans as well as a source of capital

through sales. The flexibility as regards the sale date of calves is another advantage. Stocker calves should be kept until they reach profitable weights whereas weanlings can be sold upon weaning or a few months afterwards depending upon market and forage conditions. Thus, weanlings can be available for sale for a few months while stocker calves should be sold during a period that lasts but a few weeks. Cow-calf operations, however, are not necessarily profitable. In addition, not all producers find the advantages of a cow-calf operation to be attractive. The HDM presented in Figure 3.3, with Criterion 12 eliminated, was tested by interviewing 30 producers. It was correct for 26 (86.7%) of the producers.

Limitations of Hierarchical Decision Models

Because hierarchical decision models yield qualitative (yes or no) results, they are of limited use in prescribing solutions to intercommodity resource allocation problems. For example, without an exhausting process HDMs could not be used to prescribe how many acres of corn and soybeans should be planted given the decision to plant both. Hierarchical decision models can, however, help to clarify economic issues as perceived by the economic agent in question. Therefore, they allow for better understanding of the subjective decision framework. This understanding can lead, in turn, to a better specification of constraints and objectives for optimizing models.

The limited quantitative information obtained is not the only shortcoming HDMs suffer. Because they are developed by a method that is completely dependent upon the population and its circumstances, the effectiveness of the HDMs is confined almost completely to the

population in question. Thus, hierarchical decision models should not be used to answer specific "what if" questions. For example, the effects on production of a marginal price change could not be projected or estimated via an HDM. In comparison, programming models permit sensitivity analysis to parameter, including price changes. In addition, the effects of new types of production techniques could be projected via the programming models, but HDMs cannot be utilized in such fashion. These limitations do not prevent HDMs from being complementary to optimizing programming models.

Hierarchical Decision Models and Mathematical Programming Models

Given the limitations of the HDMs as well as the need to specify mathematical programming models used for farm planning realistically, the potential complimentary aspects of the two methodologies should be realized. The potential complementary relationship between Hierarchical Decision Models and mathematical programming models is illustrated by the series of decisions of (1) whether or not to grow cash crops (Figure 3.1); (2) what to produce on land not used for commercial crops (Figure 3.2); and (3) the decision to operate a cow-calf herd or a purchased stocker herd (Figure 3.3).

Mathematical Programming Model Specification and Hierarchical Decision Models

Some of the important decision criteria in Figures 3.1, 3.2, and 3.3 were used in the specification of a Target MOTAD model of a medium-sized Jefferson County crop and beef farm. The use of a Target MOTAD model to analyze product mix and resource allocation reflects

the need, as expressed in each of the three HDMs, to explicitly consider net return, risk and the potential trade-off between them. In addition, Criterion 3 of Figure 3.3 considered a multi-year planning horizon and the need to obtain a positive annual cash flow consistently. The use of annual income targets in a Target MOTAD model mirrored these criteria.

In the case of crops, specific requirements, type of land, capital and labor were included in the HDM. These were translated into the specification of two land groups for crop production as well as annual capital and monthly labor requirements for each crop production alternative.

Similar to crops, the beef production alternatives used two types of land in addition to annual credit and monthly labor requirements. The two types of land were permanent pasture, considered to be unsuitable for crop production, and fenced non-irrigated crop land. The former were to be used for warm season improved pastures and the latter for cool season pasture and warm season native grasses. The first criterion, herd size, of the decision as to what type of beef enterprise to operate, is an economic, not a technical, requirement of production. It was mapped onto a herd size requirement in the Target MOTAD model. Flexibility (Criterion 4 of the decision tree of that decision) is also a non-technical consideration. By including various post-weaning marketing options for calves and by allowing stocker herd size to vary, the flexibility criterion was considered in the Target MOTAD model.

Knowledge and ability are producer characteristics that were included explicitly as constraints in the HDMs. When production

alternatives are included in a mathematical programming model, relevant knowledge and ability are assumed. Such was the situation in the present analysis. If, however, the producer in question stated that he lacked such knowledge and ability for specific products they would have been excluded from Target MOTAD model.

In sum, specification of a mathematical programming model can be aided by the previous development of a (series of) hierarchical decision model(s). In the present case the general type of programming model to be used was determined by the HDMs. (A Target MOTAD model has the characteristics sought.) Some of the technical and non-technical constraints were included in the Target MOTAD model because of the role they played in the decision trees. The decision criteria that were mapped directly onto the Target MOTAD model are further specified in Chapter IV.

CHAPTER IV MODEL SPECIFICATION

A Target MOTAD model of a typical, medium resource base general crop and beef farm in north Florida was developed. The objective of the model was to maximize the expected net return to management, land used for winter pasture production, operator labor, and labor used for beef production for the eleven year period, 1973-1983. The objective accurately represents the cost allocation used by producers. A discussion of the various other segments of the model is presented in the following sections. The costs and returns were first calculated in current dollars and were then transformed to constant 1977 dollars. To deflate costs, the index of "prices paid by farmers for commodities and services, interest, taxes and wage rates" was applied. The index of "all farm products" (U.S. Department of Agriculture, 1984, p. 7) was used to deflate returns.

Activities and Budgets

The crops included in the model are those that are commonly grown in Jefferson County. The warm season crops included corn (dryland and irrigated), peanuts, soybeans (dryland and irrigated), and watermelon. Cool season crops were winter wheat for grain and rye-ryegrass pasture. Bahiagrass-clover pasture and native grasses were the other

forages included in the model. All the forages were considered to be intermediate products with no commercial value. The deflated net returns used in the model for each commercial crop are given in Tables 4.3 through 4.9.

Commercial Crops and Forages

Upon review of production and cost records of two producers in Jefferson County and at the suggestion of the two producers, it was decided to utilize the commercial crop resource requirements available from the Georgia Cooperative Extension Service (University of Georgia, various issues) as the basis for the costs of all commercial crops except for watermelon. The watermelon costs of production estimates were based upon the cost estimates prepared by Hewitt (n.d.) and Westberry (n.d.). In all cases the estimated costs of production were verified with producers, agricultural scientists and other publications when applicable. The prices of the resources required for production of an acre of each crop were applied to obtain the appropriate annual cost per acre (Tables 4.3 through 4.9). Prices (Table 4.1) and yields per acre (Table 4.2) were obtained from the Florida Agricultural Statistics (Florida Crop and Livestock Reporting Service, various issues), and the U.S. Department of Agriculture (various issues, b).

The forage budgets were based primarily upon data obtained from interviews of producers. In addition a few other publications were utilized to gain insight into some aspects of machinery and equipment costs. (The forage production budgets used are presented in Appendix B). The stocking rates used for the various beef production

Table 4.1. Prices used to calculate returns.

Year	Corn ^a (bushel)	Peanuts ^a (pound)	Soybeans ^a (bushel)	Watermelon (cwt)	Wheat ^d (bushel)
\$/unit					
1973	2.55	0.162	5.65	2.725 ^b	2.60
1974	3.30	0.180	7.30	2.425 ^b	3.80
1975	2.70	0.199	4.40	3.800 ^b	3.10
1976	2.60	0.204	7.00	2.650 ^b	3.00
1977	1.60	0.207	6.00	2.350 ^b	2.20
1978	2.10	0.213	6.80	2.750 ^b	3.00
1979	2.85	0.211	6.60	3.800 ^b	3.75
1980	3.40	0.220	7.90	5.65 ^b	3.65
1981	2.85	0.273	6.20	5.35 ^b	3.32
1982	2.45	0.240	5.45	5.05 ^b	3.05
1983	3.80	0.240	8.15	4.00 ^c	3.20

^aSource: U.S. Department of Agriculture, Agricultural Prices, Annual Summary, various issues. Florida prices were used.

^bSource: Florida Crop and Livestock Reporting Service, Vegetable Summary, various issues, average June-July price.

^cPrice reported by Jefferson County producers.

^dSource: U.S. Department of Agriculture, Agricultural Prices, Annual Summary, various issues. Georgia prices used.

Table 4.2. Yields used to calculate returns.

Year	Dryland Corn (bushel) ^a	Irrigated Corn (bushel) ^b	Peanuts (pound) ^a	Dryland Soybeans (bushel) ^a	Irrigated Soybeans (bushel) ^c	Watermelon (cwt) ^d	Wheat (bushel) ^e
Unit/acre							
1973	55	110	2420	20	34	144	22
1974	52	104	3100	25	42	160	23
1975	45	90	3360	26	44	200	27
1976	66	132	2630	27	46	190	31
1977	37	74	2530	23	39	180	33
1978	40	80	3310	21	36	155	32
1979	60	120	3220	30	51	140	35
1980	60	120	2850	23	39	175	33
1981	60	120	2715	21	36	145	43
1982	70	140	2835	29	49	150	42
1983	66	132	2425	24	41	155	39

^aSource: Florida Crop and Livestock Reporting Service, Field Crop Summary, various issues. Jefferson County data were used.

^bIrrigated corn yields were assumed to be 200% of dryland corn yields.

^cIrrigated soybean yields were assumed to be 170% of dryland soybean yields.

^dSource: Florida Crop and Livestock Reporting Service, Vegetable Summary, various issues. North Florida yields were used.

^eSource: U.S. Department of Agriculture, Field Crop Summary, various issues. Georgia data were used.

Table 4.3. Deflated gross return, cost, and net return per acre:
Dryland corn.

Year	Deflated Gross Return ^a	Deflated Cost ^b	Deflated Net Return
		\$/acre	
1973	143.11	125.70	17.41
1974	163.43	148.15	15.28
1975	120.30	170.79	-50.49
1976	168.23	185.00	-16.77
1977	59.20	181.00	-121.80
1978	73.04	148.47	-75.43
1979	129.55	154.47	-24.92
1980	152.24	157.97	-5.73
1981	123.02	149.33	-26.31
1982	128.95	161.15	32.20
1983	187.16	134.16	<u>53.00</u>
Mean			-18.51

^aSee Tables 4.1 and 4.2 for details.

^bSource: University of Georgia (various issues).

Table 4.4. Deflated gross return, cost, and net return per acre:
Irrigated corn.

Year	Deflated Gross Return ^a	Deflated Cost ^b	Deflated Net Return
		\$/acre	
1973	286.22	233.94	52.28
1974	326.86	265.25	61.61
1975	240.59	316.18	-75.59
1976	336.47	272.63	63.84
1977	118.40	286.00	-167.60
1978	146.09	280.56	-134.47
1979	259.09	256.91	2.18
1980	304.48	265.94	38.54
1981	246.04	294.00	-47.96
1982	257.90	312.74	-54.84
1983	374.33	296.27	<u>78.06</u>
Mean			-16.72

^aSee Tables 4.1 and 4.2 for details.

^bSource: University of Georgia (various issues).

Table 4.5. Deflated gross return, cost, and net return per acre:
Peanuts.

Year	Deflated Gross Return ^a	Deflated ^d Cost	Deflated Net Return
		\$/acre	
1973	400.04	289.09	110.95
1974	531.43	354.32	177.11
1975	662.02	385.39	276.63
1976	526.00	402.58	123.42
1977	523.71	392.00	131.71
1978	613.07	372.22	240.85
1979	512.27	341.46	170.81
1980	467.91	338.41	129.50
1981	533.23	351.33	181.90
1982	511.58	387.90	123.68
1983	441.57	370.81	<u>70.76</u>
Mean			157.94

^aSee Tables 4.1 and 4.2 for details.

^bSource: University of Georgia (various issues).

Table 4.6. Deflated gross return, cost, and net return per acre:
Dryland soybeans.

Year	Deflated Gross Return ^a	Deflated Cost ^b	Deflated Net Return
	\$/acre		
1973	115.31	104.86	10.45
1974	173.81	100.99	72.82
1975	113.27	129.21	-15.94
1976	185.29	137.90	47.39
1977	138.00	118.10	19.90
1978	124.17	133.33	-9.16
1979	150.00	104.11	45.89
1980	135.60	121.01	14.59
1981	93.67	125.33	-31.66
1982	118.84	129.30	-10.46
1983	145.97	127.33	<u>18.64</u>
Mean			14.77

^aSee Tables 4.1 and 4.2 for details.

^bSource: University of Georgia (various issues).

Table 4.7. Deflated gross return, cost, and net return per acre:
Irrigated soybeans.

Year	Deflated Gross Return ^a	Deflated Cost ^b	Deflated Net Return
		\$/acre	
1973	196.02	194.58	1.44
1974	292.00	198.21	93.79
1975	191.68	209.21	-17.53
1976	315.69	223.63	92.06
1977	234.00	209.90	24.10
1978	212.87	230.79	-17.92
1979	255.00	212.72	42.28
1980	229.93	210.87	19.06
1981	160.58	214.67	-54.09
1982	200.79	222.29	-21.50
1983	249.37	216.77	<u>32.60</u>
Mean			17.66

^aSee Tables 4.1 and 4.2 for details.

^bSource: University of Georgia (various issues).

Table 4.8. Deflated gross return, cost, and net return per acre:
Watermelon.

Year	Deflated Gross Return ^a	Deflated ^d Cost ^b	Deflated Net Return
	\$/acre		
1973	400.41	216.90	183.51
1974	369.52	244.32	125.20
1975	752.48	272.25	480.23
1976	493.63	288.04	205.59
1977	432.00	265.40	157.60
1978	370.65	269.12	101.53
1979	403.03	337.72	65.31
1980	737.87	335.44	402.43
1981	558.09	343.53	214.56
1982	569.55	434.01	135.54
1983	462.69	458.99	<u>3.70</u>
Mean			188.66

^aSee Tables 4.1 and 4.2 for details.^bSource: 1980-1983 (Hewitt, n.d.); previous to 1980 (Westberry, n.d.).

Table 4.9. Deflated gross return, cost, and net return per acre:
Wheat.

Year	Deflated Gross Return ^a	Deflated Cost ^b	Deflated Net Return
		\$/acre	
1973	71.63	91.69	-20.06
1974	83.24	90.74	-7.50
1975	82.87	108.65	-25.78
1976	91.18	100.95	-9.77
1977	72.60	90.90	-18.30
1978	83.48	91.48	-8.00
1979	99.43	84.55	14.88
1980	89.89	93.48	-3.59
1981	102.71	102.00	0.71
1982	96.32	102.55	-6.23
1983	93.13	99.38	<u>-6.25</u>
Mean			-8.17

^aSee Tables 4.1 and 4.2 for details.

^bSource: University of Georgia (various issues).

alternatives are shown in Table 4.15. As stated above, forage was considered to have no commercial value.

Beef Cattle Enterprises

Several classes of beef cattle operations were included in the model. There were cow-calf enterprises, a summer conditioning program for calves born the previous fall, and warm and cool season backgrounding programs. (See Appendix B for the budgets of the key beef enterprises included in the model.) The purchase of calves for backgrounding was permitted in the cool season only.

Cow-calf operations

Four basic cow-calf enterprises were considered. Two calving months, March and November, with two weaning weights, 350 pounds and 450 pounds, were included. The difference in weaning weights was made possible by a longer period prior to weaning and a lower stocking rate for the cow-calf combination that produced the 450 pound calf. The monthly nutritional requirements were based upon those developed by Melton for a Brahman-cross cow in north Florida (Melton, 1978). The age of the cow and the pregnancy and lactation status were accounted for in those estimates. The assumed age distribution and the months of calving and weaning of the present study were applied to the estimates developed by Melton (1978) to obtain the nutritional requirements of the cow herd (Tables 4.10 through 4.13).

Four of the cow-calf enterprise options used bahia-clover pasture to meet warm season nutritional requirements. Another set of four

Table 4.10. Monthly energy requirements for a North Florida Brahman-cross cow^a weaning a 350 pound calf in April/May.

Month of Calving: November					
Month	Metabolizable Requirement ^b	Available Energy from Bahiagrass-Clover Pasture ^c	Available Energy from Rye-Ryegrass Pasture ^d	Energy from Hay ^e	Energy from Protein Supplement ^f
M Cal					
Nov.	606	--	115	355	136
Dec.	606	--	345	244	17
Jan.	606	--	655	--	--
Feb.	662	--	754	--	--
March	664	813	--	--	--
April	664	1524	--	--	--
May	470	1931	--	--	--
June	470	2033	--	--	--
July	488	1728	--	--	--
Aug.	512	1118	--	--	--
Sept.	553	406	--	118	29
Oct.	563	203	--	244	116

^aA composite cow, based upon a 15% culling rate.

^bBased upon Melton (1978).

^cOne acre of Bahiagrass pasture overseeded with clover.

^dOne-half acre of rye-ryegrass pasture.

^eA total of 0.6 tons of hay fed.

^fA total of 2.35 hundred weight of 30-35% protein supplement fed.

Table 4.11. Monthly energy requirements for a North Florida Brahman-cross cow^a weaning a 450 pound calf in May/June.

Month of Calving: November					
Month	Monthly Energy Requirement ^b	Available Energy from Bahiagrass-Clover Pasture ^c	Available Energy from Rye-Ryegrass Pasture ^d	Energy from Hay ^e	Energy from Protein Supplement ^f
M Cal					
Nov.	606	--	115	355	136
Dec.	606	--	345	244	17
Jan.	606	--	655	--	--
Feb.	662	--	754	--	--
March	664	975	--	--	--
April	667	1828	--	--	--
May	672	2317	--	--	--
June	600	2439	--	--	--
July	488	2073	--	--	--
Aug.	512	1341	--	--	--
Sept.	553	487	--	71	--
Oct.	563	243	--	244	58

^aA composite cow, based upon a 15% culling rate.^bBased upon Melton (1978).^cOne and two-tenths acres of Bahiagrass pasture overseeded with clover.^dOne-half acre of rye-ryegrass pasture.^eA total of 0.6 tons of hay fed.^fA total of 1.8 hundred weight of 30-35% protein supplement fed.

Table 4.12. Monthly energy requirements for a North Florida Brahman-cross cow^a weaning a 450 pound calf in October/November.

Month of Calving: March					
Month	Monthly Energy Requirement ^b	Available Energy from Bahiagrass-Clover Pasture ^c	Available Energy from Rye-Ryegrass Pasture ^d	Energy from Hay ^e	Energy from Protein Supplement ^f
M Cal					
March	606	975	--	--	--
April	606	1828	--	--	--
May	606	2317	--	--	--
June	662	2439	--	--	--
July	664	2073	--	--	--
Aug.	667	1341	--	--	--
Sept.	672	487	--	185	--
Oct.	670	243	--	324	103
Nov.	488	136 ^g	115	237	
Dec.	512	45 ^g	345	122	
Jan.	553	--	655	--	--
Feb.	563	--	754	--	--

^aA composite cow, based upon a 15% culling rate.

^bBased upon Melton (1978).

^cOne and two-tenths acres of Bahiagrass pasture overseeded with clover.

^dOne-half acre of rye-ryegrass pasture.

^eA total of 0.6 tons of hay fed.

^fA total of 90 pounds of 30-35% protein supplement fed.

^gAssumed to be available from residual pasture.

Table 4.13. Monthly energy requirements for a North Florida Brahman-cross cow^a weaning a 350 pound calf in September/October.

Month of Calving: March					
Month	Monthly Energy Requirement ^b	Available Energy from Bahiagrass-Clover Pasture ^c	Available Energy from Rye-Ryegrass Pasture ^d	Energy from Hay ^e	Energy from Protein Supplement ^f
M Cal					
March	606	813	--	--	--
April	606	1524	--	--	--
May	606	1931	--	--	--
June	662	2033	--	--	--
July	664	1728	--	--	--
Aug.	667	1118	--	--	--
Sept.	470	406	--	70	--
Oct.	470	203	--	244	23
Nov.	488	89 ^g	115	284	--
Dec.	512	45 ^g	345	122	--
Jan.	553	--	655	--	--
Feb.	563	--	754	--	--

^aA composite cow, based upon a 15% culling rate.

^bBased upon Melton (1978).

^cOne acre of Bahiagrass pasture overseeded with clover.

^dOne-half acre of rye-ryegrass pasture.

^eA total of 0.5 tons of hay fed.

^fA total of 20 pounds of 30-35% protein supplement fed.

^gAssumed to be available from residual pasture.

options used native grass pastures instead of bahia-clover. The native grasses were assumed to be Guinea grass and crab grass growing in fields that produced cool season forage. The grasses thus utilized residual fertilizer. The assumed stocking rate for the heavier weaning alternative was one cow per 1.5 acres of native grass as compared to one cow per 1.2 acres of improved pasture. In addition, the enterprises that utilized native grass required additional supplemental feeding to meet nutritional requirements. Upon weaning, calves were either sold or passed to a feeding program.

In order to determine the weight of calves available for sale, several assumptions and calculations were made. The majority of the assumptions were averages derived from a survey of 50 Jefferson County beef producers. A calving rate of 92% and a 2% calf mortality rate were assumed. Thus 90 calves would be available from 100 cows. Assuming that 50% of the calves were bulls and 50% were heifers, 45 calves of each type were available. Of these, 15 heifer calves were assumed to be required for cow replacement. In sum, 45 steer calves and 30 heifer calves, a total of 75 from a potential 100 were assumed to be available for a post-weaning option. On the basis of a cow and calf pair the assumed situation dictated that sales weight was 75% of the assumed 350 pound and 450 pound weaning weights.

Postweaning

It was assumed that an individual calf started a post-weaning production option at one of the two possible weaning weights. Thus, when the assumptions concerning the calf crop were applied to the

post-weaning production options, it was necessary to assume that 1.33 cows (1.0 cow divided by 0.75 calves per cow = 1.33 cows per calf) were required to produce one calf. In this dissertation conditioning was defined as a 90 to 120 day backgrounding program. Conditioning was considered only when lush warm season grazing was available. At the end of the conditioning program additional gain would be necessary to attain finishing weight.¹

Final calf weights of the conditioning and backgrounding programs were estimated by a growth simulation model for stocker cattle (Spreen et al., 1985). The final weight (Table 4.14) was then reduced by 2% to account for calf mortality and for calves born at the end of the calving season. This weight was then multiplied by the appropriate monthly price to obtain an estimate of total returns. A marketing fee of one and one-half percent was also deducted from total returns to arrive at the gross returns used to calculate the net returns (Table 4.15) used in the model.

The weight and receipts estimates were made in a similar fashion for the purchased-calf backgrounding options. Two of these options were included to reflect different situations. In the first option, the purchased stocker option was independent from the cow-calf options. Both were charged proportional shares for warm season pasture production. In the other option, the stocker enterprise was charged with the warm season improved pasture production costs. The cows, however, were permitted to graze the residual pasture cost-free.

¹Pre-conditioning is the post-weaning phase which prepares calves for shipping. Calves are vaccinated and allowed to graze good forage in order to prepare them for the stress of transport.

Table 4.14. Initial and final weights, beginning months, number of months and stocking rates of specified post-weaning programs.

	Initial Weight	Final Weight	Beginning Months	Number of Months	Stocking Rate	
					Bahia- clover	Rye- ryegrass
					Head per acre	
Conditioning:						
Light calf	350	515	April/May	4	2.0	NA ^b
Heavy calf	450	592	June	3	1.0	NA ^b
Heavy calf	450	510	June	3	2.0	NA ^b
Backgrounding of fall calf:						
Light calf	350	767	April/May	12	1.0	1.5
Light calf	350	746	April/May	12	2.0	2.0
Heavy calf	450	856	June	10	1.0	1.0
Heavy calf	450	796	June	10	2.0	1.5
Backgrounding of spring calf:						
Light calf	350	670	October	7	5.0 ^a	1.5
Light calf	350	642	October	7	5.0 ^a	2.0
Heavy calf	450	727	November	6	5.0 ^a	2.0
Backgrounding of purchased calf:	400	658	December	5	5.0 ^a	2.0

^aFor the month of April only.

^bNA denotes not applicable.

Table 4.15. Final weights and average (1973-1983) deflated gross returns, costs and net returns per head of principal beef enterprises.

	Final weight ^a	Average deflated gross returns ^c	Average deflated costs	Average deflated net returns
	pounds	dollars per head		
<u>Cow-Calf on bahia-clover</u>				
Fall calf weaned light	350	165.39 ^b	196.68	-31.29
Fall calf weaned heavy	450	195.81 ^b	200.83	- 5.02
Spring calf weaned light	350	142.07 ^b	163.46	-21.39
Spring calf weaned heavy	450	169.49 ^b	186.86	-17.32
<u>Cow-Calf on native grass</u>				
Fall calf weaned light	350	165.39 ^b	151.73	13.66
Fall calf weaned heavy	450	195.81 ^b	157.93	37.88
Spring calf weaned light	350	142.07 ^b	127.34	14.73
Spring calf weaned heavy	450	169.49 ^b	160.61	8.88
<u>Conditioning</u>				
Light calf	515	218.74	300.07	-81.33
Heavy calf	592	256.44	332.90	-81.46
Heavy calf	510	216.62	303.59	-86.97
<u>Backgrounding of fall calf</u>				
Light calf	767	316.90	390.10	-73.20
Light calf	746	308.23	359.30	-51.07
Heavy calf	856	357.81	413.76	-55.95
Heavy calf	796	332.73	367.40	-34.67

Table 4.15--Continued.

	Final weight ^a	Average deflated gross returns ^c	Average deflated costs	Average deflated net returns
	pounds	dollars per head		
<u>Backgrounding</u> <u>of spring calf</u>				
Light calf	670	280.06	286.77	- 6.71
Light calf	642	267.68	280.21	-12.53
Heavy calf	727	303.89	319.81	-15.92
<u>Backgrounding of</u> <u>purchased calf</u>				
	658	274.06	215.18	58.88
<u>Cow-calf linked with</u> <u>purchased stocker calf</u>				
Fall calf weaned heavy	450	195.81 ^b	159.46 ^c	36.35
Purchased calf	658	274.06	226.33	47.73

^aCorresponds to weights in Table 13.

^bIncludes income from cull cows.

^cIncludes cost of cow-calf operation at production of 1.33 cows per stocker calf.

Given that the stockers were sold in early May, this system permitted the cows to receive supplemental feeding in April and early May and graze cost-free through the summer. Both situations had a 2.0 stocking rate for the stocker calves on the rye-ryegrass pasture.

Two variations of a purchased stocker enterprise were included because other stocking rates proved to be much less attractive. A lower stocking rate of 1.5 was too costly and had a much lower net return because of under utilization of resources. A higher stocking rate (2.5) required that more supplements be purchased or caused a lower rate of gain to occur, which resulted in a lower net return than the 2.0 stocking rate option.

The Constraints

All production options, either crop or livestock, require resources. It is the technical constraints of a programming model that describe the resource base available to the economic agent. Other, non-technical constraints describe other types of requirements. Both types are described in the following subsections.

Technical Constraints

The major technical constraints are the basic agricultural inputs--land, labor and capital. Land and labor resources available were considered to be identical every year. The amount of available labor, however, varied on a monthly basis while the amount of land available was held constant both on a monthly and annual basis. The per unit (per head of cattle and per acre of each crop) requirements

for land and labor for each commodity did not vary. The capital requirements for each commodity did vary annually. The variation was necessary because, unlike the objective function, the capital requirements and constraints were valued in current dollars.

Land and labor

Four types of land--irrigated crop land, unfenced non-irrigated crop land, fenced non-irrigated crop land and permanent pasture--were included in the model (Table 4.16). No transformation of land from one type to another was permitted. Prohibiting the transformation of permanent pasture to crop land is a result found in the HDM analysis of the decision as to whether to produce commercial row crops. The separate accounting of fenced, non-irrigated crop land is also consistent with the HDM analysis. Some producers, including those explicitly used to develop the target MOTAD model, stated that they have had, or anticipated, erosion problems due to such a transformation. It was decided to hold irrigated, dry crop land and fenced acreage at actual levels of availability on a specific farm (Table 4.16). This was done so that the results of the model could be compared to an actual situation. Thus, the constraints for all four land groups were specified at existing levels.

Similar to other inputs, land costs were charged on an as-used basis. Thus, costs were net of land purchase costs for unused land. As stated above, land costs that were charged varied over the eleven-year period. In addition, the charges for each of the land groups was distinct. Although peanuts were not produced on irrigated land, the

Table 4.16. Available acreage by land type.

Land Type	Acreage
Irrigated crop land	200
Total non-irrigated crop land	550
Fenced non-irrigated crop land	125
Permanent pasture	90

land use charge for their production was at the irrigated land rate. This was done in accordance with rental practices common to the Florida Panhandle.

Unlike land, labor was considered to be homogeneous. Labor availability was based upon the employment of two full-time workers--an owner/manager and a full-time employee. Monthly labor availability (Table 4.17), however, varied by month. Consistent with work load requirements, both the employee and the farm operator were assumed to be available to work more hours during the warm season than during the cool season. It was also assumed that the employer would perform proportionately more work during the cool season. These assumptions conform with the practice of using the off-season to compensate employees for overtime worked during the cropping season.

Similar to crop land used for winter forage production, labor used in beef production was treated as a residual and no charge was made for it. This conforms with the time flexibility of chores related to beef and forage production as well as the attempt of producers to keep employees active all year. In accordance with normal procedures in Jefferson County, crop labor was charged at the minimum wage rate for the year in question.

Capital

The capital requirements used in the model were based entirely upon short-term production credit. They were to cover all out-of-pocket cash expenses for production purposes. Fixed costs, the cost of capital items such as machinery and land purchase charges were not

Table 4.17. Monthly labor availability.

Month	Available Man-Hours
January	360
February	387
March	462
April	462
May	473
June	462
July	473
August	473
September	462
October	344
November	294
December	294

Table 4.18. Annual production loan funds available.

Year	Available Loan Funds
	————— \$ —————
1973	200,000
1974	200,000
1975	200,000
1976	200,000
1977	250,000
1978	250,000
1979	250,000
1980	300,000
1981	300,000
1982	300,000
1983	300,000

included in the credit requirements of the various products. Interest was charged at the annual rate indicated by the Georgia Extension Service. The amount available annually (Table 4.18) was based upon a limit of 300,000 dollars for 750 acres of crop land available, an average of 400 dollars per acre for 1983. This amount was then adjusted to conform with the index of "farm real estate value" reported in the table entitled "Economic Trends" (U.S. Department of Agriculture, 1984b), and was then rounded off to the nearest 50,000 dollars).

Non-Technical Constraints

In addition to the technical requirements of land, labor and capital, non-technical requirements and constraints were also specified. Foremost among these were the minimum income targets.

Income constraints and variation

The income requirements were set on the basis of interviews with producers. Based upon the interviews it was determined that 15,000 dollars would be considered a good farm income in 1983. To this figure 9,000 dollars was then added. The addition was made to allow for capitalization and payment for some of the unused resources. The sum was deflated by the 1977 consumer price index. The target income was 14,000 dollars in 1977 constant dollars. The scalar λ was the parameter that controlled the total of the annual negative deviations from the annual target. When λ was unconstrained, the model was similar to a straightforward linear programming model. As λ was made

smaller via parametric programming, smaller total annual negative deviations from the annual target were permitted. When λ became sufficiently small, changes in the solution basis occurred. The values of λ and the annual income targets are related. Just as the target was held constant and the amount of permitted deviation varied, the level of deviation was held constant and the target varied. The result was a range of targets which can be viewed as the area of interest for each set value of λ . The lowest value of the range for a given value of λ is the target which can be attained each year. The upper band of the range is the highest income target that can be attained with a specific level of permitted deviation. The solution to the latter is the linear programming solution to a net return maximization problem with a negative income deviation constraint.

Peanut and watermelon acreages

The history of the various methods used to control peanut acreage and production in the United States is well known. In 1982, the United States changed from the strict acreage control of the allotment program to the quota system. The quota system is based upon weight and guarantees that a specific weight (the quota) can be sold at a subsidized price. The possibility of having some type of restriction/subsidy was allowed for with a corresponding constraint. It was also thought that watermelon might enter a solution at unrealistically high levels. The capability of restricting watermelon acreage was built into the model as well. Neither of these constraints were activated for the initial solution attempt.

CHAPTER V RESULTS AND ANALYSIS

Introduction

The results from two specifications of the model are presented below. The difference between the specifications is that the level of watermelon acreage was unconstrained in one and was limited to a maximum of 40 acres in the other. The former specification is referred to as the unconstrained model and the latter is referred to as the constrained model. Both sets of results are based upon the results of parametric programming. The scalar λ which controlled the total amount of negative deviation from annual income targets was lowered systematically until its value was zero. As determined by the solution algorithm, specific values of λ caused the solution basis to change. At each change of the basis, the value of λ and the results were reported.

Previous to the summary discussion, however, a short review of a preliminary model is presented. In the preliminary model the value of λ was not varied or constrained. Peanut, watermelon and fenced dry land crop acreage also were unconstrained. It was anticipated that the optimal stocker herd size might have been at the lower limit of 25 head, but with a smaller true optimum. This would have caused a discrete programming problem which allowed the stocker herd size to be zero. The preliminary solution indicated a large herd size so this

was not an issue. Thus, the preliminary model was the same as the two ultimately used to complete the present study.

Because of the large positive net returns generated by peanuts and watermelon as compared to the other commercial crops included in the study, it was anticipated that peanuts and watermelon would dominate the solution. This is what occurred. Approximately 90 acres of watermelon and 120 acres of peanuts were included in the solution. In addition, a fall stocker herd of 450 head was indicated. Given a stocking rate of 2.0 per acre this meant 225 acres of nonirrigated crop land was utilized for forage production in the cool season. To try to overcome the discrepancy between observed and modeled behavior, peanuts were limited to 70 acres. This resulted in watermelon production increasing to approximately 110 acres.

The producer whose resource base was being explicitly included in the model was contacted and the solution was discussed with him. He stated that in previous years he used about 235 acres for cool season production divided among 110 acres for wheat and 125 acres for cool season pasture. He stated that he has been limited to 125 fenced acres for the pasture. Thus, the fenced acreage constraint level was specified. In addition, he stated that he was planning to reduce his watermelon acreage to 30 to 40 acres because of harvest labor difficulties. This observation determined the watermelon acreage constraint. Favorable experience with the peanut quota the previous year had made him decide to expand from one contract to three. Because of the ability to sell more than the amount allocated under the quota at the set price, he stated that he would produce about 90 acres of peanuts.

These considerations were included as constraints in the Target MOTAD model. The results from the model with no watermelon constraint, the fenced acreage constraint, and the peanut acreage constraint of 90 acres are presented and analyzed first. Next, the results and analysis of the constrained model are given. When appropriate, a comparison is made between the results of the two model specifications.

Results and Analysis: Unconstrained Watermelon Acreage

After the initial solution of unconstrained set of models, only two changes in basis occurred in order to arrive at the point at which no variation from the targeted income of 14,000 dollars took place in any of the 11 years (i.e., when $\lambda = 0$). The products included in the solution varied somewhat as the amount of variation changed (Table 5.1). There was a trade-off between variation and income (Table 5.1). Income and variation were at their greatest values as well as their lowest levels simultaneously.

Annual Income Levels and Commodities

With the exception of 1974, the target income was attained every year in all solutions of the unconstrained model (Table 5.2). When income variation was not controlled the 11 year average income obtained from the production of nuts, watermelon and a purchased stocker herd was enough to maximize net return. No particular year was of concern as regards the attainment of the target income. If

Table 5.1. Net return, product mix and level of negative deviation from income targets for both models.

λ^c	Net Return	Peanut	Watermelon	Irrigated Soybeans	Purchased Stockers	Brood Cows ^a	Native Brood Cows ^b
	---\$---	-----	Acres	-----	-----	Head	-----
Unconstrained Model							
≥ 600.75	40,371.30	90.0	108.8	0.0	250	0	0
150.06 to 600.75	39,265.00	90.0	108.8	78.8	150	0	0
0.00 to 150.06	38,281.70	90.0	109.7	79.7	226	0	0
Constrained Model							
≥ 1692.50	29,572.50	90.0	40.0	0.0	250	0	0
1181.50 to 1692.50	29,166.10	90.0	40.0	0.0	214	35	0
652.70 to 1181.50	26,919.70	90.0	40.0	160.0	214	35	0
465.90 to 652.80	25,738.70	90.0	40.0	160.0	193	32	8
0.00 to 465.90	22,259.80	90.0	40.0	84.6	113	19	40

^aThese cows graze residual permanent pasture.

^bThese cows graze native grass pasture during the warm season.

^c λ is the sum of the products of negative deviations from annual income targets times the probability of occurrence of such a deviation.

Table 5.2. Annual levels of expected net return and levels of total negative deviations from annual income targets for both models.

λ	Unconstrained Model			Constrained Model				
	600.75 ^a to 600.75	150.06 to 600.75	0.0 150.06	1,692.50 ^a to 1,692.50	1,181.50 to 1,181.50	652.70 to 1,181.50	465.90 to 652.70	0.0 to 465.90
----- Dollars -----								
Year								
1983	35,938.19	40,954.60	38,281.72	33,546.70	31,605.27	41,790.87	40,150.16	29,075.00
1982	43,963.22	39,821.50	37,598.88	36,775.00	34,819.29	26,409.69	24,501.87	21,161.90
1981	44,970.82	38,233.42	37,248.25	23,370.10	32,381.89	18,701.89	17,883.00	21,191.77
1980	45,700.17	44,753.78	45,423.70	20,150.60	24,875.96	22,954.36	23,767.87	27,785.60
1979	39,753.60	40,657.44	38,509.85	37,380.00	39,118.93	40,954.13	39,593.68	33,523.00
1978	56,772.30	52,810.23	49,974.26	52,013.40	49,503.76	41,458.96	39,068.46	33,709.80
1977	36,496.22	35,739.74	34,517.86	27,971.90	25,171.54	23,635.54	22,290.25	17,865.90
1976	43,274.80	47,849.14	46,513.83	31,470.10	27,960.81	37,248.81	35,669.54	25,252.60
1975	83,911.17	79,939.65	79,066.17	53,132.80	49,212.09	41,148.09	39,725.55	38,079.80
1974	7,324.95	12,332.67	14,000.00	791.70	2,580.63	12,748.63	14,002.00	14,000.00
1973	19,088.81	16,974.61	17,585.60	8,408.30	12,291.87	7,999.07	8,823.57	14,000.00

^aThis value was indicated by the solution. All values greater than it would have the same basis.

the negative deviation from the annual target of a particular year was great relative to the amount of variation permitted, the solution basis might have to change. Furthermore, under the controlled situation, if a particular product had a bad year the solution would be influenced. Such was the case of the present model in 1974.

The net return for the purchased stocker operation was low in 1974 relative to the mean (used as the objective function value). Irrigated soybeans, which had a good year in 1974, entered the solution in order to compensate for the deviation caused by the stocker herd. Soybeans had a good year because the product prices were favorable, not because of extraordinary yields. Peanuts and watermelon were the only viable alternatives to the irrigated soybeans. Peanut acreage was already at its upper limit and could be expanded no further. Because March labor was already fully utilized, watermelon acreage could not be increased.

The availability of fenced crop land for cool season pasture limited stocker production when variation from the target was unconstrained. This was also true when soybean production was adequate to off-set the variation. It was only when no variation was permitted that the stocker herd decreased.

When no negative variation in net return was permitted, the addition of the irrigated soybean production was not enough to off-set the variation from the target. Thus, the stocker herd was reduced from 250 head to 226 head. The reduction freed some labor so that an additional acre each of irrigated soybeans and watermelon could be produced.

Peanut and Watermelon Acreage

March labor availability was the factor that limited watermelon production in the unconstrained model. Thus, for the resource base available watermelon production was at its optimum. In comparison, peanut production was limited by an exogenous variable, the peanut quota.

In the preliminary specification of this model, peanut acreage was not controlled. Optimum peanut production was appreciably greater than the controlled amount finally indicated. Thus, there was a loss in net return due to the diminished production. This loss was \$87.51 per acre when variation in annual income was not constrained and \$71.42 under both levels of control. The amount was less than the value to the objective function of an acre of peanuts. The reduction in value occurred because watermelon production would have had to be reduced in order to permit increased peanut production to occur.

Resource Use

Most of the available resources were not used entirely in order to arrive at the various optimum solutions. For example, the use of borrowed capital ranged from 35.7% in 1977 when income was allowed to vary freely to 65.8% in 1982 and 1979 when a moderate level of variation was allowed. Irrigated land use ranged from 19.7% to 94.8% (Table 5.3). The only use for dry crop land was peanut production. Thus, its use was of low intensity. A maximum of 43% of such land was used.

Table 5.3. High and low use of borrowed capital, labor, irrigated land, and dry crop land by level of deviation of net return for both models.^a

λ^b	Borrowed Capital		Labor		Irrigated Crop Land ^d		Dry Crop Land	
	High	Low	High	Low ^c	High	Low	High	Low
----- % -----								
Unconstrained Model								
600.75	61.8 (82)	35.7 (77)	100 (3)	8.5 (e)	54.4 (f)	0.0 (g)	39.1 (3)	16.4 (h)
150.06	65.8 (i)	43.4 (73)	100 (j)	8.5 (12)	93.8 (k)	19.7 (11)	39.1 (3)	16.4 (h)
0.0	63.7 (82)	37.5 (77)	100 (j)	7.7 (12)	94.8 (k)	39.9 (11)	37.0 (3)	16.4 (h)
Constrained Model								
1692.50	52.0 (79)	29.4 (77)	61.7 (4)	0.0 (1)	20.0 (f)	0.0 (g)	39.1 (3)	16.4 (h)
1181.50	48.6 (79)	28.8 (77)	74.9 (3)	4.9 (1)	20.0 (f)	0.0 (g)	39.1 (3)	16.4 (1)
652.70	56.7 (79)	35.3 (77)	84.4 (4)	4.9 (1)	10.0 (k)	20.0 (m)	39.1 (3)	16.4 (1)
465.90	53.9 (79)	34.2 (77)	83.7 (4)	5.5 (1)	100 (k)	20.0 (m)	37.6 (3)	18.6 (1)
0.0	40.6 (82)	26.7 (73)	72.9 (3)	7.9 (1)	62.4 (k)	20.0 (m)	31.9 (3)	15.5 (n)

^aThe numbers in parenthesis represent the year for borrowed capital (1983=83, etc.) or month (January=1, ..., December=12) for the other resources of high and low use.

^bThe specific values of λ are those indicated in the computer solutions. Values of λ , however, refer to the upper values of the appropriate range.

^cFor the unconstrained model January is excluded because no January labor is used with any value of λ .

^dIn either model no irrigated crop land is used in January or December.

^eNovember and December had equal use.

^fFebruary through June, inclusive, had equal use.

^gAugust through November, inclusive, had equal use.

^hApril through September, inclusive, had equal use.

ⁱThe years 1982 and 1979 had equal use.

^jMarch and April had equal use.

^kMay and June had equal use.

^lMay through September, inclusive, had equal use.

^mFebruary and March had equal use.

ⁿNovember, December, January, and February had equal use.

Of the resources available only labor in March and April and fenced acreage proved to be binding when watermelon was not limited (Table 5.3). March labor had values of \$71.18 per additional man-hour when annual income was permitted to vary freely and \$47.68 in both instances the variation was controlled. April labor, which was binding only when the variation from the target income was controlled, had a value of \$46.88 per man-hour in both cases.

April labor availability affected the value of fenced acreage in the case when negative annual income variation was permitted at a moderate level. Because of the April labor requirements of the purchased stocker herd, if more than 125 fenced acres were available only 125 acres would be used. In comparison, when annual income variation was not controlled, an additional acre of fenced crop land would have added \$52.55 to the mean net return of the 11 year period (Table 5.4).

Results and Analysis: Constrained Watermelon Acreage

The results of the constrained model follow the same pattern as those of the unconstrained model. Because watermelon production could not be used to meet the target income to the extent as in the unconstrained model, more changes in basis occurred as less deviation from the target was permitted. In addition, variation was greater and income less at all comparable steps in the constrained model as compared to the unconstrained model (Table 5.2).

Table 5.4. Opportunity cost/marginal values per acre of the peanut quota, constrained watermelon acreage, and fenced crop land by level of deviation of expected net return for both models.

Model	λ	Peanut Quota	Watermelon Acreage	Fenced Crop Land
\$/acre				
<u>Unconstrained</u>				
	600.75	87.51	NA ^a	52.55
	150.06 to 600.75	71.47	NA ^a	0.0
	0.0 to 150.06	71.42	NA ^a	NA ^b
<u>Constrained</u>				
	1692.50	126.24	156.96	95.46
	1181.50 to 1692.50	207.15	245.15	47.67
	652.70 to 1181.50	231.80	269.20	34.08
	465.90 to 652.70	244.30	293.52	31.41
	0.0 to 465.90	244.30	293.52	31.41

^aNot applicable. Watermelon acreage was not constrained directly.

^bNot applicable. Not all fenced acreage was used in this alternative.

Annual Income and Commodity Production

As in the case of the unconstrained model, 1974 proved to be a year in which it was difficult for the constrained model to attain the income target. The reason for this is the same as in the unconstrained model. The decrease in watermelon acreage in the constrained model, however, caused 1973 to be a year in which earning \$14,000 was difficult as well. The target was difficult to reach in 1973 because, like 1974, it was a bad year for stocker operations (Table 5.2).

When variation from targeted income was controlled slightly ($\lambda = 1181.5$), the purchased stocker herd was reduced from 250 to 214 head (Table 5.1). The reduction helped to compensate for the variation from target income caused by the poor years of 1973 and 1974 as well as the reduced watermelon acreage. In addition, a 35 head cow herd which grazed residual warm season pasture was included in the solution. The brood cow enterprise selected was based upon improved warm season pasture. Calving occurred in November and the weaning weight was 450 pounds in this enterprise. This addition enabled the fenced crop land to be fully utilized despite the reduction in the stocker herd. The 1973 income situation was improved by including the cow herd. The reduction of the stocker herd improved the 1974 situation.

These changes were not enough to compensate for stricter control of the negative deviation from targeted income ($\lambda = 652.7$). As in the unconstrained model, the inclusion of irrigated soybeans decreased the variation. The addition of 160 acres of soybeans, however, caused all

irrigated acreage to be utilized in May and June (Table 5.3). Thus, the tighter control of variation ($\lambda = 465.9$) required other changes in product mix to be made. Total annual negative deviation from the income target would increase with the reduction of peanut and watermelon acreage and would decrease increases of their acreages. Such an increase was prohibited by direct constraints. Once again a decrease in the stocker herd size (Table 5.3) helped to decrease the 1974 variation. The decrease in herd size was not large enough to do away with the 1974 variation entirely. This reduction in income deviation was partially effected by a decrease in the cow herd that grazed residual warm season pasture. The herd was reduced from 35 to 32 head. Furthermore, eight cows which grazed native grasses during the warm season were included in the solution. Calves produced under this option were born in the fall and weaned at 450 pounds in the spring.

When no negative deviation from annual income targets was permitted ($\lambda = 0$), the size of the cow herd which grazed native pasture in the warm season was increased from eight to 40 head. In addition, the size of the other cow herd was decreased from 32 to 19 head. These changes permitted a decrease in the soybean acreage to occur. That decrease was necessary because, although the 1974 income situation could be improved by soybean production, a concomitant deterioration occurred in 1973. This occurred because poor yields prevented irrigated soybeans from covering land use fees in 1973. Thus, while improving the average situation when some negative annual

income variation was permitted, soybeans made the 1973 situation worse when no variation was permitted.

Peanut and Watermelon Acreage

The restriction of peanut acreage had additional value to the objective function in the set of solutions when watermelon acreage was constrained. This value was lowest when income variation was not controlled and greatest when variation was tightly controlled. The values ranged from \$126.24 per acre (the explicit value of an acre of peanuts to the objective function) to \$244.30 per acre (Table 5.4). The value of an additional acre of peanuts increased because, unlike the unconstrained watermelon situation, peanuts were not in competition with watermelon for March labor.

It is clear that an increase in watermelon acreage would increase the value of the objective function in the constrained acreage set of solutions. The additional amount to be earned ranged from the explicit value used in the objective function (\$156.96 per acre) when income variation was not controlled to \$293.52 per acre when only slight variation was permitted. The latter value held when no variation was permitted (Table 5.4). This was an analogous situation to that of peanuts. The value of an additional acre of watermelon increased because of the lack of competition for March labor with other crops.

Resource Use

As could be expected, resource use was generally lower in the constrained model than in the unconstrained model. This was true

because the stocker herd size was smaller in the unconstrained model in all but one case. More importantly, the limited watermelon acreage also limited resource use.

The use of capital was much less intensive when watermelon acreage was constrained. The greatest percentage of production credit used was 56.7% (as compared to 65.8% in the unconstrained case). The lowest percentage was 26.7% in the constrained model. Overall, the lowest percentage of credit was used when negative income variation from the target was not permitted and the highest was when moderate variation was permitted and 160 acres of soybeans were produced.

The set of solutions under constrained watermelon acreage did not require as much labor as in the unconstrained set. Again, restricted watermelon acreage caused this outcome (Table 5.3). Nonirrigated crop land was little used. It was used slightly more in the constrained model only when it was used as a source of native grass pasture.

One hundred sixty acres of irrigated soybeans constituted the use of irrigated crop land in both the constrained and unconstrained models. Low net return to soybean production (Table 4.7) with the exception of the year which caused soybeans to be used in the solution (1974), combined with limited watermelon production resulted in additional irrigated land having no imputed value to the objective function even when such land was used completely. (This means that the dual was degenerate.)

In comparison, fenced crop land warranted additional value in all solutions of the constrained model (Table 5.4). The value decreased from \$95.46 per acre when income variation was not controlled to

\$31.41 when it was not permitted ($\lambda = 0$). This reflects the decrease in the size of purchased stocker herd and the increase in the lower-valued brood cow herd.

Income Targets and Variation

In order to determine the effects of specific annual income targets on the solutions at specified levels of negative deviation from that target, income targets were varied parametrically at fixed levels of λ . A range of income targets which influenced the solutions was obtained. Target values that induced changes in solution bases and the solutions were reported. These values are presented in Table 5.5. The specific values of λ used were those that induced changes of solution bases in the model specifications with fixed target incomes. The general trends in optima product mixes are also presented. The differences between these solutions and the solutions obtained with fixed targets and varying values of λ are highlighted. For all values of λ , the lowest target income enabled the optimum expected net return obtained to equal the optimum expected net return attained when λ was varied and the target set. The range of economic interest of the target was greatest in the unconstrained model when no deviation was permitted (Table 5.5). In general, the range was greater for the unconstrained model than in the constrained model. This is as would be expected because of the potential that watermelon production had for meeting income targets.

Table 5.5. Degree of negative deviation from target incomes low and high targets attained with corresponding net returns.

		Low Target		High Target	
	λ^a	Target Value	Net Returns	Target Value	Net Returns
----- dollars -----					
Unconstrained Model	0.0	7,324.95	40,371.35	23,750.38	26,902.60
	150.5	8,997.17	40,371.35	24,370.11	27,343.81
	602.0	14,013.84	40,371.55	25,986.40	28,465.02
Constrained Model	0.0	791.70	29,572.50	16,544.16	18,396.36
	466.0	5,969.48	29,572.50	18,932.46	17,446.45
	652.8	8,045.03	29,572.50	19,470.76	17,863.12
	1,181.6	8,408.30	29,572.50	20,994.63	19,044.85
	1,692.5	14,002.78	29,572.50	22,057.38	23,048.17

^aThe values of λ were specified and target incomes were varied.

The Unconstrained Model and Target Income Variation

Three levels of negative deviations were specified in the unconstrained model (Table 5.5). The values were those obtained when the income target was specified. For each level of deviation a range of economic interest of target incomes was determined (area AA of Figure 5.1). The upper and lower bounds of area AA of Figure 5.1 represent the approximate bounds of the area of economic interest. For a given value of λ income targets greater than the upper limit of the range cannot be attained (area BB of Figure 5.1). Income targets less than the lower limits are not binding. Thus, the solutions are similar to those of a standard linear programming problem (area CC of Figure 5.1). The range of the values of the target income was greatest (\$16,425.43) when no variation was permitted ($\lambda = 0$). The range was smallest (\$11,972.56) when the permitted variation was greatest ($\lambda = 602.0$). Within this set of ranges income target levels influence optimal product mix (Table 5.5).

In the model specifications in which the degree of variation from target was varied. Fourteen thousand dollars was the specified target income. The target of \$14,000 was low relative to the entire range when λ was greater than zero. It was only slightly less than the computed value when permitted variation was greatest.¹

As in the models specified with fixed income targets, the product mix was dominated by peanuts, watermelon and purchased stocker calves (Table 5.6). The product mix was also stable. Nonirrigated soybeans

¹This was caused by rounding error. The computed value should have been exactly \$14,000.

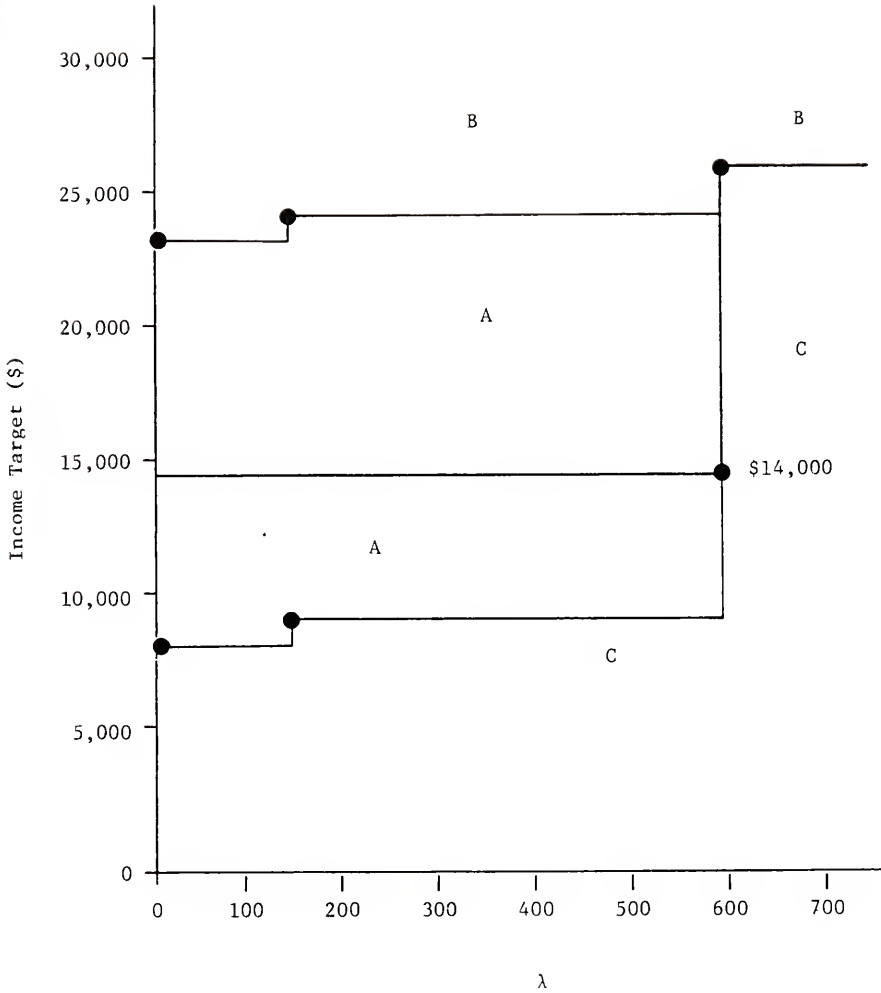


Fig. 5.1. Income target limits obtained for specific levels of λ , unconstrained model.

was the only product which was included in this set of solutions which was not included when income targets were fixed. As in the case of irrigated soybeans, dry land soybeans were introduced into the solution when it became more difficult to satisfy the relevant constraint.

The stability in net returns that dry land soybean production accomplished, however, was not cost-free. As the target income increased and soybean production increased in order to obtain the target in 1973, expected net returns decreased. Thus, expected net returns attained and the target value drew closer together. The difference was greatest when no negative deviations were permitted and smallest when the greatest amount of deviation occurred (Table 5.6).

In contrast to dry land soybeans the herd size of the purchased stocker herd decreased as the target increased. This occurred in order to stabilize 1973 and 1974 targets as well. The cow herd, however, increased (Table 5.6). The cow herd which grazed native grasses became more important as the target income increased. In comparison, there was no cow herd of any type included in the solutions of the unconstrained model with a fixed target income.

The Constrained Model and Target Income Variation

An approximation of the range of economic interest of the target incomes in the constrained model is represented by area AA in Figure 5.2. The range was smaller in the constrained model than in the unconstrained model. It was smaller because of the watermelon constraint which induced lower valued infeasible target incomes to occur. There was also a trade-off between increased income targets and

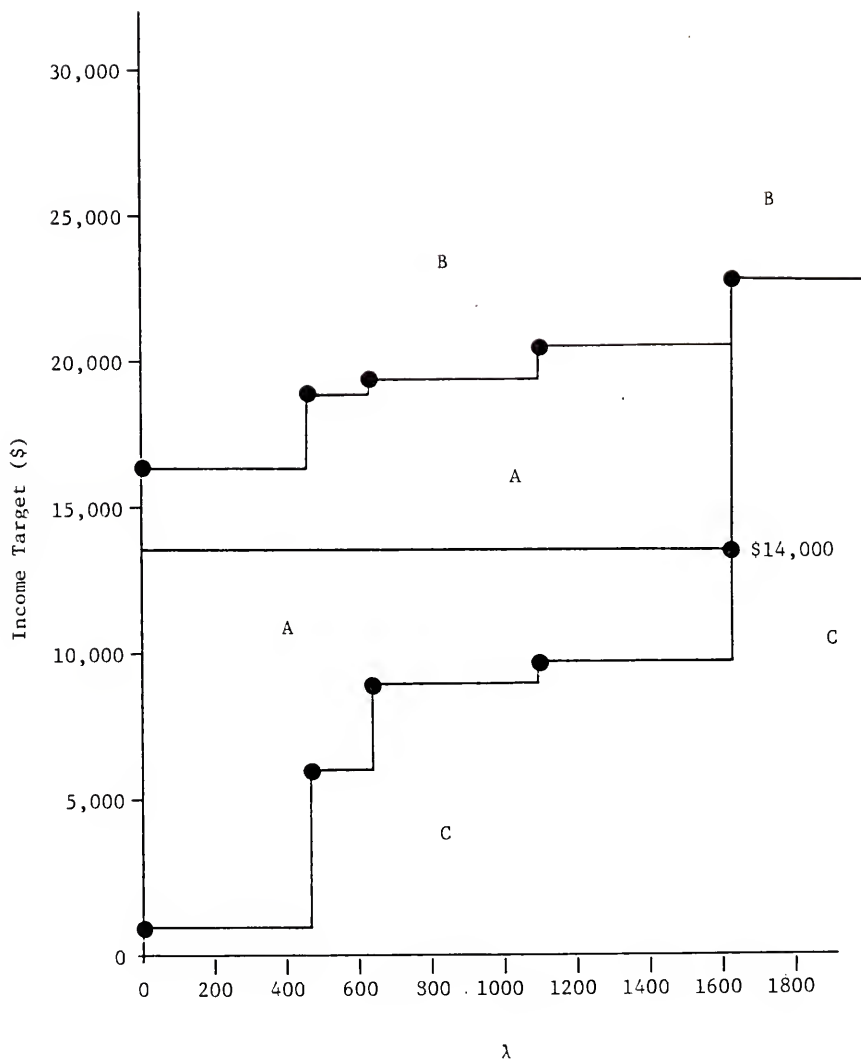


Fig. 5.2. Income target limits obtained for specific levels of λ , constrained model.

Table 5.6. Degree of negative deviation from target incomes, income-targets, and optimum product mix for the unconstrained model.

	Income Target	Peanuts	Water- melon	Dryland Soybeans	Irrigated Soybeans	Purchased Stockers	Cows on Improved Pasture	Cows on Native Grasses
	--\$--	----- Acres -----				----- Head -----		
$\lambda = 0.0$	7,324.95	90.0	108.8	0.0	0.0	250	0	0
	12,332.69	90.0	109.7	0.0	79.7	226	0	0
	19,659.59	90.0	112.9	0.0	82.9	142	0	0
	22,694.69	90.0	116.0	0.0	47.6	70	0	0
	23,088.29	90.0	109.4	0.0	58.4	60	0	17
	23,750.38	90.0	100.8	122.7	0.0	74	0	37
$\lambda = 150.5$	8,997.17	90.0	108.8	0.0	0.0	250	0	0
	14,004.91	90.0	108.8	0.0	78.8	250	0	0
	18,692.34	90.0	111.4	0.0	81.4	184	0	0
	22,299.06	90.0	114.4	0.0	84.4	110	0	0
	23,845.84	90.0	118.0	0.0	66.4	71	0	0
	23,850.94	90.0	116.0	0.0	65.5	71	0	0
	23,877.33	90.0	116.0	3.6	64.0	71	0	0
	24,173.41	90.0	112.1	58.5	37.9	77	0	9
	24,370.11	90.0	101.9	126.4	0.0	82	0	34
$\lambda = 602.0$	14,013.84	90.0	108.8	0.0	0.0	250	0	0
	17,582.27	90.0	108.8	0.0	56.2	250	0	0
	17,998.09	90.0	108.8	0.0	78.8	250	0	0
	25,393.28	90.0	114.9	0.0	84.9	98	0	0
	25,503.21	90.0	115.3	0.0	65.9	88	0	0
	25,742.63	90.0	115.0	32.6	52.5	94	0	0
	25,986.40	90.0	102.4	116.7	5.5	99	0	31

expected return. The decrease in the value of the objective function was approximately equal in both the constrained and unconstrained models. Thus, the relative decrease was greater for the constrained model because the levels of net return attained were lower. The fixed income target of \$14,000 was either at the upper end of the range of economic interest in the middle of the range in four of five cases (Table 5.7). This occurred because the watermelon constraint prevented annual net return from obtaining as high values as they did in the unconstrained model.

The solutions and crop mix of the constrained model followed the same pattern as those of the unconstrained model. As the target income constraint tightened, more dry land soybeans were included in the solutions (Table 5.7). Simultaneous with this increase there was a decrease in irrigated soybean. These changes occurred because dry land soybeans had greater net returns than irrigated soybeans in 1973. Because the dry land beans contributed less to the objective of maximizing expected net return, however, the value of the objective function declined as it did in the unconstrained model (Tables 5.5, 5.6, and 5.7).

The sizes of the cow herds included in the solutions were larger than in the unconstrained model (Tables 5.7 and 5.8). The limited watermelon acreage helped to induce this result as target incomes increased. The decreases in size of the purchased stocker herd was approximately the same in the constrained model as in the unconstrained model (Tables 5.6 and 5.7). The decline occurred in order to increase 1973 and 1974 net returns.

Table 5.7. Degree of negative deviation from target incomes, income-targets, and optimum product mix for the constrained model.

	Income Target	Peanuts	Water- melon	Dryland Soybeans	Irrigated Soybeans	Purchased Stockers	Cows on Improved Pasture	Cows on Native Grasses
	--\$--	-----	Acres	-----	-----	-----	Head	-----
$\lambda = 0.0$	791.70	90.0	40.0	0.0	0.0	250	0	0
	6,147.25	90.0	40.0	0.0	84.3	250	0	0
	9,409.01	90.0	40.0	0.0	107.4	214	35	0
	15,633.52	90.0	40.0	0.0	76.5	76	12	54
	16,544.16	90.0	40.0	115.3	0.0	83	13	51
$\lambda = 466.0$	5,969.48	90.0	40.0	0.0	0.0	250	0	0
	7,684.32	90.0	40.0	0.0	27.0	250	0	0
	10,946.08	90.0	40.0	0.0	50.0	214	35	0
	12,962.74	90.0	40.0	0.0	160.0	214	35	0
	14,003.94	90.0	40.0	0.0	160.0	193	32	8
	16,702.81	90.0	40.0	0.0	146.6	133	22	31
	17,416.85	90.0	40.0	0.0	128.6	112	19	40
	18,918.84	90.0	40.0	191.4	0.0	122	20	35
	18,932.46	90.0	40.0	170.2	0.0	95	15	46
$\lambda = 652.8$	8,045.03	90.0	40.0	0.0	0.0	250	0	0
	8,399.46	90.0	40.0	0.0	4.0	250	0	0
	11,562.22	90.0	40.0	0.0	27.2	214	35	0
	14,000.52	90.0	40.0	0.0	160.0	214	35	0
	16,628.52	90.0	40.0	0.0	160.0	161	26	20
	17,985.39	90.0	40.0	0.0	125.0	120	20	36
	19,454.76	90.0	40.0	187.3	0.0	130	22	32
	19,470.76	90.0	40.0	162.3	0.0	97	16	45
$\lambda = 1181.6$	8,408.30	90.0	40.0	0.0	0.0	250	0	0
	11,164.44	90.0	40.0	0.0	0.0	250	0	0
	14,000.69	90.0	40.0	0.0	0.0	214	35	0
	16,938.29	90.0	40.0	0.0	160.0	214	35	0
	17,924.12	90.0	40.0	0.0	160.0	194	32	8
	19,594.83	90.0	40.0	0.0	117.9	144	24	27
	20,971.88	90.0	40.0	175.5	0.0	154	26	23
	20,994.63	90.0	40.0	139.9	0.0	107	18	42
$\lambda \geq 1692.5$	14,002.78	90.0	40.0	0.0	0.0	250	0	0
	16,839.03	90.0	40.0	0.0	0.0	214	35	0
	19,586.64	90.0	40.0	0.0	149.7	214	35	0
	21,149.79	90.0	40.0	0.0	110.3	168	28	18
	23,048.17	90.0	40.0	115.7	32.6	174	29	16

Summary of Results

When the target income was fixed at \$14,000, the net return values for the set of solutions under the situation when watermelon acreage was unconstrained was stable. Expected return ranged from \$40,400 when negative deviations from annual income targets were uncontrolled to about \$38,300 when such deviations were not permitted. When income targets were varied for fixed levels of λ (a measure of negative deviations from those targets) expected net returns ranged from about \$40,000 to approximately \$27,000. In comparison, expected net returns were lower and varied more when watermelon acreage was constrained. Expected net return was about \$29,600 when negative deviations were not controlled and decreased to about \$22,800 when the deviations were prohibited.

Peanuts and watermelon were the dominant commercial crops in all sets of solutions. With a fixed target income, irrigated soybeans were included in the solution only when negative income deviations were controlled. This was the only other crop that was prescribed. A review of recent changes in production made by the producer whose resource base was used in the model is given in Table 5.8. As is revealed, the model accurately depicted the beef, peanut, watermelon and wheat situations. Only as regards corn and soybeans was the model inaccurate. The producer stated, however, that if the 1985 corn and soybean crops proved to be like those of the past few years he would reconsider their production. He stated that he would probably stop producing corn and cut back his soybean acreage. Thus, the model did

Table 5.8. Review of recent producer action.

Producer Action (Last year This year)		Comment
1. Wheat	110 acres → 0	The model was confirmed, producer stated "last year it didn't pay to take my combine out."
2. Watermelon	90 → 30-40 acres	The model was accurate. The producer cut-back because of harvest labor problems. The original model indicated about 90 acres.
3. Peanuts	35 → 80-90 acres	
4a. Corn	200+ acres	The producer stated that if corn and soybeans performed this year as they had the past few, he'd cut-back drastically. The farmer was considering not producing corn.
4b. Soybeans	400 acres	

analyze the situation accurately from the point of view of the producer.

To a great extent the changes that occurred in the set of solutions under constrained watermelon acreage as well as unconstrained watermelon acreage reflect the situation of the early 1970's. During the period income derived from soybean production was high and that from a variety of beef enterprises was low. Thus, even when watermelon acreage was not constrained directly, soybean production took place and the size of the prescribed purchased stocker calf herd decreased as the control of negative income deviations tightened. When deviation was controlled somewhat the amount of soybeans under the unconstrained watermelon situation was about half of that when watermelon was constrained directly (79 acres versus 160 acres). The soybean acreages were about equal when no deviation was permitted (79.7 acres versus 84.6 acres).

Unlike soybeans, the differences in the various beef operations that were prescribed became larger as control of the negative deviations from target incomes became more strict. Under both sets of models with a fixed income target the purchased stocker herd was set at 250 head when income variation was not controlled. The herd size decreased to 226 head when watermelon acreage was not constrained directly and no negative income deviation was permitted. When watermelon production was limited to 40 acres the herd size decreased to 113 head. Brood cows were included in the solution only when watermelon production was constrained. The cow herd, however, was prescribed only when income variation was controlled. The cow herd

varied in size from 35 head to 59 head as the amount of total negative deviation from annual income targets diminished. Because spring calf prices were greater than fall calf prices all calves produced were fall calves. These calves were weaned and sold in the spring. No spring calves were produced for backgrounding during the cool season. All stocker calves were purchased in December. Because stocker calves were purchased and were not spring calves weaned in the fall, the fall forage availability problem was avoided.

In general, the set of models with varied income targets paralleled the set of models with a fixed target income. Ninety acres of peanuts were indicated in all solutions. Watermelon acreage was also approximately the same in the unconstrained model. Forty acres of melons were included in all the solutions of the constrained model. Dry land soybeans was the only crop that was included in the models with varied income targets that was not included in the models with a fixed target. Dry land soybeans, like irrigated soybeans in the latter model, were included to help stabilize incomes in the early 1970's. Similar to soybeans, the beef herds fluctuated in size in order to affect the situation in that period. As the target increased, the purchased stocker herd size decreased from 250 head to less than 100 head in the unconstrained model. It also decreased from 250 head to slightly more than 100 head in the constrained model except when permitted variation was greatest ($\lambda = 1692.50$). The cow herd increased in size as the target increased. Much of the increase in size was because of increases in the size of the cow herd that grazed native grasses in the warm season.

CHAPTER VI SUMMARY AND CONCLUSIONS

Summary

Beef cattle production comprises an important group of activities throughout the southeastern United States. In this region, beef producers often produce agronomic and horticultural crops as well as cattle. Yet, farm planning models which include beef production alternatives have not successfully included beef herds in their solutions. Either beef has been excluded from the solutions or both brood cow herds and stocker calf herds have been included at unrealistic levels.

It was anticipated that the use of hierarchical decision models to aid in the specification of a mathematical programming model of a typical medium-sized north Florida crop and beef farm would overcome the analytical problem. The series of HDMS that was developed indicated that risk plays an important role in decision-making by producers. A Target MOTAD model was developed to answer questions about herd sizes of both cow and stocker calf herds, calving season and weaning weights as well as crop mix. The period of analysis was the years 1973 through 1983. The objective of the model was to maximize expected net returns for the time period.

Target MOTAD satisfies the conditions for second degree stochastic efficiency. In addition, Target MOTAD has the benefit of

using a linear programming algorithm to solve the constrained optimization problem. The solution set of a parametric programming problem based upon a Target MOTAD model is a (in terms of the objective function and constraint set) subset of second degree stochastic dominant efficient solutions.

Four general model specifications were analyzed. In two of the specifications target income was set (at \$14,000) for each year and the degree of permitted negative deviation from that target was varied parametrically. In the remaining two, the degree of deviation was set at the values that induced changes in solution bases in the former set. The target income was then varied for each of these levels of deviation. For each of these specifications one group of models was specified with watermelon acreage constrained at 40 acres or less. In another group, watermelon acreage was unconstrained. In all model specifications a maximum of 90 acres of peanuts was allowed.

When watermelon acreage was unconstrained and the target income fixed, the amount of irrigated soybean acreage was the only major change in the solutions. As the degree of permitted negative deviation from income targets decreased, the soybeans acreage increased. This occurred in order to stabilize 1973 and 1974 incomes. Labor availability limited watermelon acreage. Ninety acres of peanuts were included in all the solutions of this model. No brood cows were included in this set of solutions and the purchased stocker herd was over 200 head for all values of λ , a measure of the deviation.

When watermelon acreage was constrained and the annual income target fixed, 40 acres of watermelon and 90 acres of peanuts were

indicated for all degrees of deviation from the target. Irrigated soybean acreage was greater and more variable under this model specification than in the corresponding unconstrained model. The greatest contrast between the two model specifications with fixed target incomes was the type and size of beef cattle herds included in the various solutions. With the exception of when the level of negative deviation from the target was uncontrolled, the purchased stocker herd sizes were much smaller in the constrained model than in the unconstrained model. Brood cows were included in all but one solution of the constrained model with fixed income targets. As the level of income deviation decreased, the cow herd increased in size. The configuration of the herd also varied. It changed from one that grazed only improved pasture in the warm season to one that was much more dependent upon warm season native grasses. No matter the source of warm season forage, all calves were born in the fall and sold upon weaning in the late spring. The heavier weaning option of 450 pounds was the one selected in all cases.

The solutions of both model specifications with fixed values of λ were similar to those of their corresponding models with fixed income targets. Ninety acres of peanuts, the maximum allowed, were included in all solutions. Watermelon acreage was approximately equal in all cases of the unconstrained models. Forty acres, the upper bound, of watermelon were included in all constrained model solutions. Soybean production was the means used to increase 1973 and 1974 incomes to meet the target income requirement. Soybean acreage was generally less in the specification with varied income targets. Dry land soybeans entered the solution. As the target incomes increased,

the acreage allotted to dry land soybeans increased in both the unconstrained and the constrained models. The changes in cow herd size and configuration were similar with either varied income targets or the degree of permitted negative deviation varied.

Conclusions

Based upon these results and analyses several conclusions can be made. The majority are related to product mix, but two concern methodology. The conclusions regarding products are made with the objective of trying to diminish negative annual deviations from desired income.

The production of high-valued crops would help the producer to attain income goals. The acreage allotted to such crops should be stable over time. The production of a staple crop, such as soybeans, causes income stability. The staple crop should be carefully selected each year. Crops, however, usually need some specialized equipment. Thus, in order to conform with this recommendation, either certain tasks would have to be custom hired or the producer would have to own the equipment. If the equipment is not owned already, however, careful analysis must be made before it is purchased. The outcome of such an analysis would, in part, depend upon how many acres are involved. The acreage planted should also be selected annually. Each decision should be based upon the expectations of the producer about market and growing conditions.

A small brood cow herd would also help to stabilize income. Calves should be born in the fall and weaned in the late spring. They should be sold upon weaning. A purchased stocker calf herd of from

150 to 200 head would improve the income situation. Herd size should vary according to anticipation of market conditions, while taking calf purchase price into account.

As regards methodology, two major conclusions can be drawn from the present study. First, hierarchical decision models can be used to help specify mathematical programming models. HDMs would be most useful in specifying the aspects related to the decision framework or criteria of the economic agent. Proper specification promotes mathematical programming models which are realistic. Second, stability of the solutions under different targets implies that the specification of an income target is not critical as long as it is within the proper range.

Limitations of the Present Study and Recommendations for Future Research

The present study is the first effort to apply hierarchical decision models to the specification of a mathematical programming model. Although the attempt was successful as verified by realistic results, there are several weaknesses in the overall analysis. They relate to the mathematical programming model rather than to the general approach used in the analysis.

The influence that a specific year or two had on optima product mixes was described in the text. This was caused by the small number of years (11) used in the study. The influence is particularly problematic when, as in the case of this research, the early years of the series unduly influence the solutions. One way to overcome the problem would be to expand the number of observations. Alternately,

some type of rational expectations model could be used to assign the probabilities of the annual short-falls in income. The author prefers the latter because an expansion of the time frame of the study would probably exceed the explicit time frame used by producers for decision making.

Another limitation concerns the data. Final calf weights were assumed. The assumptions were based upon the forage production of an average year. Thus only price variability caused returns to vary. An attempt should be made to include weight variability in a study similar to the present one.

Finally, the objective of maximizing net returns pertains in this research because the debt and equity aspects of the farm problem that currently exists in the United States do not apply to the producer upon whom the present study is based. To increase generality, returns to investment should be explicitly considered in future work. This would require more information than was used in this research concerning the asset and debt situation on a product by product basis.

It is realized that the geographic scope of this dissertation is limited. The indicated refinements to a model that includes proper (regional) technical coefficients should assist producers in the southeastern United States in their search for solutions to their resource allocation problems.

APPENDIX A DECISION TREES

Reading Decision Trees

A decision tree (Figure A.1) is a technique to identify and place key decision criteria into a logical framework. It is used to predict actual choices by individuals. The criteria (denoted by < >) form questions which can be answered by either a yes or a no, each response leading to a different path or branch. The criteria are numbered in order to facilitate the referral to specific points or criteria. The goals or reasons motivating the decision comprise the first level of criteria. Usually only one reason or goal is necessary to move on to the constraints. All the constraints must be passed in order for the model to conclude that the activity in question will be performed. The constraints form the second level of criteria. Each branch ultimately leads to an outcome or choice (denoted by □).

The Decision to Impose Controlled Breeding

The decision tree of the decision as to whether or not to impose controlled breeding or a limited breeding season on a cow herd is presented here (Figure A.1). It is used because it is a relatively simple decision and therefore the tree is easily read. The first five questions are reasons why a producer could be interested in imposing controlled breeding. Two relate to calving rates, one relates to calf

management, one relates to the available labor of the producer and one relates to marketing strategy. In all, four types of reasons are considered. A producer could be dissatisfied with the present calving rate and think that controlled breeding would improve the rate (Criteria 4 and 5). He would then, the model predicts, consider imposing controlled breeding on his cow herd. The producer could be satisfied with the calving rate, but think that a calf crop born in a three or four month period would help improve his calf management situation (Criterion 2). The model predicts that he would consider imposing a limited breeding season on his herd. The constraints are also varied. They relate cash flow, income, knowledge and pasture availability. Criteria 7 and 8 are minimum requirement constraints. A minimum amount of knowledge and pasture are required to be able to establish a controlled breeding program. If either of the requirements is not met then controlled breeding cannot be imposed.

Taken together, eight categories of information are subjectively considered by the producer. What one producer considered to be "enough" might be considered insufficient by another. Even though they are subjective, some criteria are easily quantified while others are not.

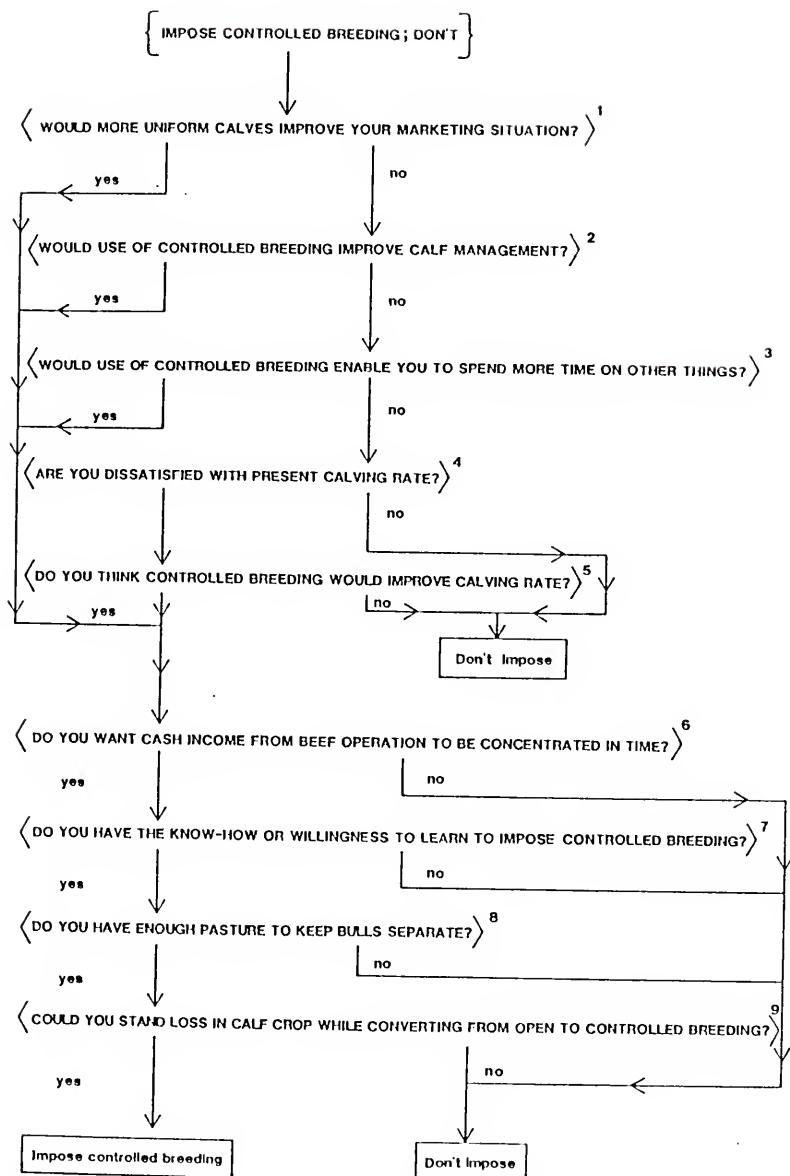


Fig. A.1. The decision to impose controlled breeding.

APPENDIX B
CATTLE RELATED PRODUCTION COSTS

Table B.1. Costs per acre of producing a rye-ryegrass pasture.

Cash Expenses	Resource Requirement	Dollars per acre										
		1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
Seed												
Rye ^a	1.5 bu	1.45	5.25	6.00	5.95	6.45	6.75	7.05	7.60	8.85	9.00	9.00
Ryegrass ^a	20.0 lbs	2.40	3.00	3.40	3.40	3.60	3.80	4.00	4.20	5.00	5.00	5.00
Fertilizer												
5-10-15	5 cwt	13.75	22.50	27.00	23.75	22.50	22.50	22.50	30.00	34.25	38.75	38.75
N	25 lbs	2.50	5.00	6.75	6.25	5.00	5.25	5.00	6.50	7.00	8.35	7.25
Lime	1/6 T	1.70	2.00	2.70	2.70	2.70	2.70	2.70	3.35	3.70	4.00	4.20
Machinery ^b	1 acre	1.82	2.45	4.00	3.78	3.65	3.79	4.19	4.99	5.28	4.44	4.50
Repairs and Fencing ^c	1 acre	1.40	1.75	2.00	2.05	2.20	2.35	2.60	2.80	2.95	2.95	3.00
S. Total		27.72	41.95	51.85	47.90	46.10	44.45	48.05	59.45	67.05	72.50	71.70
Fixed Expenses												
Machinery ^b												
Labor	0.8 hour	2.92	3.87	5.50	5.75	5.85	6.08	6.72	7.84	8.18	6.07	6.14
Total less labor		1.45	1.45	1.60	2.00	2.40	2.60	2.80	3.20	3.60	3.80	4.00
		30.64	45.82	57.35	53.65	51.95	50.53	54.77	67.24	75.23	78.57	77.84

^aPrice indexed from 1982 and 1983 base price, using seed price index, U.S. Department of Agriculture, Agricultural Prices, Annual Summary, June 1984.

^bSource: Ross et al. (1983).

^cPrice indexed from 1983 base price using building and fencing index, U.S. Department of Agriculture, Agricultural Prices, Annual Summary, June 1984.

Table B.2. Costs per acre of producing a bahiagrass-clover pasture.

Cash Expenses	Resource Requirement	Dollars										
		1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
Fertilizer												
5-10-15	4 cwt	11.00	18.00	21.60	20.00	18.00	18.00	20.00	24.00	27.40	31.00	31.00
Clover seed	15 lbs	8.10	11.25	11.85	11.70	12.65	13.35	13.95	15.00	17.40	17.85	17.85
Lime	1/4 T	2.50	3.00	4.00	4.00	4.00	4.00	4.00	5.00	5.50	6.00	6.25
Labor	1.0 hour	1.80	1.80	2.00	3.00	3.00	3.25	3.50	4.00	4.50	4.75	5.00
Rent	1.0 acre	10.00	10.00	10.00	15.00	15.00	15.00	15.00	20.00	20.00	20.00	20.00
Equipment ^{a,b}	1.75 hr/acre	0.95	1.15	1.35	1.30	1.30	1.35	2.75	3.20	3.50	4.40	4.85
Tractor ^{a,c}	0.4 hr/acre	0.50	0.70	0.80	0.85	0.90	0.95	1.05	1.45	1.60	1.75	1.90
Interest on cash expenses		2.35	3.55	4.50	4.80	4.70	4.75	5.40	6.90	9.85	13.00	12.30
S. Total less labor		35.40	47.65	54.10	56.65	56.55	57.40	62.15	75.55	85.25	94.00	94.15
Fixed Expenses												
Tractor ^{a,c}	0.4 hour	0.50	0.60	0.70	0.75	0.85	0.90	1.60	1.80	2.00	2.15	2.30
Equipment ^{a,b}	1.75 hour	1.20	1.35	1.65	1.90	2.05	2.20	6.10	6.75	7.50	8.15	8.90
S. Total		1.70	1.95	2.35	2.65	2.90	3.10	7.70	8.55	9.50	10.30	11.20
Total less labor		37.10	49.60	56.40	60.30	59.45	60.50	69.85	84.10	94.75	104.30	105.35
Total less interest and labor		34.75	46.05	51.95	55.50	54.75	55.75	64.45	77.20	84.90	91.30	93.05

^aSource: Anderson and Hipp (1974, 1976).^bThe 1974 cost served as the base cost for 1973 and 1975-1978. The 1981 cost was the base for 1979, 1980, 1982 and 1983. For cash expenses the Farm and Motor Supplies Index was used and for fixed expenses the Other Machinery Index was used, both from ULS. Department of Agriculture, Agricultural Prices, Annual Summary, June 1984.^cThe 1974 cost served as the base cost for 1973 and 1975-1978. The 1981 cost was the base for 1979, 1980, 1982 and 1983. For cash expenses the Fuels and Energy Index was used; for fixed expenses the Tractors and Self-Propelled Machinery Index was used, both from U.S. Department of Agriculture, Agricultural Prices, Annual Summary, June 1984.

Table B.3. Costs per head of overwintering a 350 pound spring farm-raised calf to 670 pounds at a 1.5 stocking rate.

Variable Cash Production Expenses	Resource Requirement	Dollars										
		1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
Rye-ryegrass pasture	0.67 acres	22.48	30.72	38.43	35.95	34.81	33.87	36.72	45.09	50.42	52.66	52.16
Hay	1.5 cwt	3.00	4.05	4.13	3.75	4.80	4.13	3.98	3.98	5.10	5.25	5.94
Fuel and maintenance	212 days	0.64	1.06	1.06	1.27	1.27	1.27	1.70	2.33	2.76	2.54	2.54
Medicine		1.29	1.46	1.96	2.13	1.92	1.80	1.84	1.96	2.13	2.28	2.40
Salt and minerals		0.63	0.71	0.96	1.04	0.94	0.88	0.90	0.96	1.04	1.11	1.17
Interest	8 months	1.34	2.03	2.79	2.65	2.62	2.52	2.86	3.62	5.33	6.81	6.42
S. Total		30.02	40.03	49.33	46.79	46.36	44.47	48.00	57.94	66.78	70.65	70.63
<u>Other Costs</u>												
Marketing ^a		4.52	3.73	3.17	3.66	3.43	5.24	8.05	6.30	6.01	6.15	6.08
Transportation ^b		0.41	0.44	0.60	0.67	0.71	0.76	0.80	1.04	1.42	1.61	1.54
Overhead ^b		0.98	1.18	1.34	1.47	1.56	1.61	1.75	2.00	2.22	2.40	2.55
S. Total		5.91	5.35	5.11	5.80	5.70	7.61	10.60	9.34	9.65	10.16	10.17
Total costs		35.93	45.38	54.44	52.59	52.06	52.08	58.60	67.28	76.43	80.81	80.80

^aEstimated as 1.5% of gross receipts.

^bSource: Ross et al. (1983).

Table B.4. Costs per head of backgrounding a 450 pound fall farm-raised calf to 796 pounds.

Cash Expenses	Resource Requirements	Dollars										
		1973	1973	1975	1976	1977	1978	1979	1980	1981	1982	1983
Rye-Ryegrass pasture	0.67 acres	22.48	30.72	38.43	35.95	34.81	33.87	36.72	45.09	50.42	52.66	52.16
Permanent pasture	0.5 acres	17.38	23.03	25.93	27.75	27.38	27.88	32.23	38.60	44.70	45.65	46.53
Hay	5 cwt	10.00	13.50	13.75	12.50	16.00	13.75	13.25	13.25	17.00	17.50	19.80
Fuel and maintenance	334 days	1.00	1.67	1.67	2.00	2.00	2.00	2.67	3.67	4.34	4.01	4.01
Medicine		2.58	2.92	3.92	4.26	3.84	3.60	3.68	3.92	4.26	4.56	4.80
Salt and minerals		1.26	1.42	1.92	2.08	1.88	1.76	1.80	1.92	2.08	2.22	2.34
Interest		3.51	5.37	7.06	6.98	7.09	6.84	7.87	9.76	14.63	18.57	17.83
S. Total		58.21	78.63	92.68	91.52	93.00	89.70	98.22	116.21	137.43	145.17	147.47
Other Costs												
Marketing ^a		5.37	4.43	3.76	4.35	4.07	6.22	9.56	7.49	7.14	7.31	7.22
Transportation ^b		0.41	0.44	0.60	0.67	0.71	0.76	0.80	1.04	1.42	1.61	1.54
Overhead ^c		1.96	2.36	2.68	2.94	3.12	3.22	3.50	4.00	4.44	4.80	5.10
S. Total		7.74	7.23	7.04	7.96	7.90	10.96	13.86	12.53	13.00	13.72	13.86
Total costs		65.95	85.86	99.72	99.48	100.90	100.66	112.08	128.74	150.43	158.89	161.33

^aEstimated as 1.5% of gross receipts.^bSource: Ross et al. (1983).^cBased upon Ross et al. (1983), but due to length of period, overhead is estimated to be twice those given in Ross et al.

Table B.5. Costs per head of overwintering a 350 pound spring farm-raised calf to 642 pounds at a 2.0 stocking rate.

Variable Cash Production Expenses	Resource Requirement	Dollars										
		1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
Rye-KyeGrass pasture	0.5 acres	16.78	22.93	28.68	26.83	25.98	25.28	27.40	33.65	37.63	39.30	38.93
Hay	2.5 cwt	5.00	6.75	-6.88	6.25	8.00	6.88	6.63	6.63	8.50	8.75	9.90
Fuel and maintenance	212 days	0.64	1.06	1.06	1.27	1.27	1.27	1.70	2.33	2.76	2.54	2.54
Medicine		1.29	1.46	1.96	2.13	1.92	1.80	1.84	1.96	2.13	2.28	2.40
Salt and minerals		0.63	0.71	0.96	1.04	0.94	0.88	0.90	0.96	1.04	1.11	1.17
Interest	8 months	1.19	1.76	2.37	2.53	2.57	2.44	2.74	3.42	4.51	5.76	5.49
S. Total		26.67	34.67	41.91	40.05	40.68	38.55	41.21	48.95	56.57	59.74	60.43
Other Costs												
Marketing		4.33	3.57	3.03	3.51	3.28	5.02	7.71	6.04	5.76	5.89	5.83
Transportation		0.41	0.44	0.60	0.67	0.71	0.76	0.80	1.04	1.42	1.61	1.54
Overhead		0.98	1.18	1.34	1.47	1.56	1.61	1.75	2.00	2.22	2.40	2.55
S. Total		5.72	5.19	4.97	5.65	5.55	7.39	10.26	9.08	9.40	9.90	9.92
Total costs		32.39	39.86	46.88	45.70	46.23	45.94	51.47	58.03	65.97	69.64	70.35

Table B.6. Costs per head of backgrounding a 350 pound farm-raised fall calf to 746 pounds.

Variable Cash Production Expenses	Resource Requirement	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
Dollars												
Permanent pasture	0.5 acres	17.83	23.03	25.98	27.25	27.38	27.88	32.23	38.60	42.45	45.65	46.53
Rye-fryegrass	0.5 acres	16.78	22.93	28.68	26.83	25.98	25.28	27.40	33.65	37.63	39.30	38.93
Hay	7.5 cwt	15.00	20.25	20.63	18.75	24.00	20.63	19.88	19.88	25.50	26.25	29.70
Fuel and maintenance	365 days	1.10	1.83	1.83	2.19	2.19	2.19	2.92	4.02	4.75	4.38	4.38
Medicine		2.58	2.92	3.92	4.26	3.84	3.60	3.68	3.92	4.26	4.56	4.80
Salt and minerals		1.29	1.42	1.92	2.08	1.88	1.76	1.80	1.92	2.08	2.22	2.34
Interest	12 months	3.79	5.79	7.47	7.32	7.67	7.32	8.35	10.20	15.17	19.58	19.00
S. Total		57.92	78.17	90.43	88.68	92.94	88.66	96.26	112.19	131.84	141.94	145.68
Other Costs												
Marketing		4.94	4.52	3.26	4.01	3.79	5.45	8.82	6.96	6.75	6.70	6.84
Transportation		0.41	0.44	0.60	0.67	0.71	0.76	0.80	1.04	1.42	1.61	1.54
Overhead		1.96	2.36	2.68	2.94	3.12	3.22	3.50	4.00	4.44	4.80	5.10
S. Total		7.31	7.32	6.54	7.62	7.62	9.43	13.12	12.00	12.61	13.11	13.48
Total costs		65.23	85.49	96.97	96.30	100.56	98.09	109.38	124.19	144.45	155.05	159.16

Table B.7. Costs per head of backgrounding a 450 pound farm-raised fall calf to 856 pounds.

Cash Expenses	Resource Requirement	Dollars										
		1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
Rye-Ryegrass pasture	1.0 acres	33.55	45.85	57.35	53.65	51.95	50.55	54.80	67.30	75.25	78.60	77.85
Permanent pasture	1.0 acres	34.75	46.05	51.95	55.50	54.75	55.75	64.45	77.20	84.90	91.30	93.05
Hay	4 cwt	8.00	10.80	11.00	10.00	12.80	11.00	10.60	10.60	13.60	14.00	15.84
Fuel and maintenance	334 days	1.00	1.67	1.67	2.00	2.00	2.00	2.67	3.67	4.34	4.01	4.01
Medicine		2.58	2.92	3.92	4.26	3.84	3.60	3.68	3.92	4.26	4.56	4.80
Salt and minerals		1.26	1.42	1.92	2.08	1.88	1.76	1.80	1.92	2.08	2.22	2.34
Interest		5.21	7.97	10.54	10.52	10.50	10.28	12.02	15.09	21.98	28.56	27.21
S. Total		86.35	116.68	138.35	138.01	137.72	134.94	150.02	179.70	206.41	223.25	225.10
<u>Other Costs</u>												
Marketing		5.78	4.76	4.05	4.67	4.38	6.69	10.29	8.05	7.68	7.86	7.77
Transportation		0.41	0.44	0.60	0.67	0.71	1.52	0.80	1.04	1.42	1.61	1.54
Overhead		1.96	2.36	2.68	2.94	3.12	3.22	3.50	4.00	4.44	4.80	5.10
S. Total		8.15	7.56	7.33	8.28	8.21	11.43	14.59	13.09	13.54	14.27	14.41
Total costs		94.50	124.24	145.68	146.29	145.93	146.37	164.61	192.79	219.95	237.52	239.51

Table B.8. Costs per head of conditioning a 350 pound farm-raised fall calf to 515 pounds.

Cash Expenses	Resource Requirement	Dollars										
		1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
Permanent pasture	0.5 acres	17.38	23.03	25.98	27.75	27.38	27.88	32.23	38.60	42.45	45.65	46.53
Fuel and maintenance	153 days	0.46	0.77	0.77	0.92	0.92	0.92	1.22	1.68	1.99	1.84	1.84
Medicine		1.29	1.46	1.96	2.13	1.92	1.80	1.84	1.96	2.13	2.28	2.40
Salt and minerals		0.63	0.71	0.96	1.04	0.94	0.88	0.90	0.96	1.04	1.11	1.17
Interest	5 months	<u>0.58</u>	<u>0.87</u>	<u>1.11</u>	<u>1.19</u>	<u>1.17</u>	<u>1.18</u>	<u>1.43</u>	<u>1.80</u>	<u>2.58</u>	<u>3.39</u>	<u>3.25</u>
S. Total		20.34	26.84	30.78	33.03	32.33	32.66	37.62	45.00	50.19	54.27	55.19
<u>Other Costs</u>												
Marketing		4.48	1.78	1.78	2.17	2.51	5.21	7.38	5.64	4.63	4.36	4.32
Transportation		0.41	0.44	0.60	0.67	0.71	0.76	0.80	1.04	1.42	1.61	1.54
Overhead		<u>0.65</u>	<u>0.79</u>	<u>0.89</u>	<u>0.98</u>	<u>1.04</u>	<u>1.07</u>	<u>1.17</u>	<u>1.33</u>	<u>1.60</u>	<u>1.60</u>	<u>1.70</u>
S. Total		<u>5.54</u>	<u>3.01</u>	<u>3.27</u>	<u>3.82</u>	<u>4.26</u>	<u>7.04</u>	<u>9.35</u>	<u>8.01</u>	<u>7.65</u>	<u>7.47</u>	<u>7.56</u>
Total costs		25.88	29.85	34.05	36.85	36.59	39.70	46.97	53.01	57.84	61.74	62.75

Table B.9. Costs per head of conditioning a 450 pound farm-raised fall calf to 510 pounds.

Cash Expenses	Resource Requirement	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
		Dollars										
Permanent pasture	0.5 acres	17.38	23.03	25.98	27.75	27.38	27.88	32.23	38.60	42.45	45.65	46.53
Fuel and maintenance	92 days	0.28	0.46	0.46	0.55	0.55	0.55	0.74	1.01	1.20	1.10	1.10
Medicine		0.65	0.73	0.98	1.07	0.96	0.90	0.92	0.98	1.07	1.14	1.20
Salt and minerals		0.32	0.36	0.48	0.52	0.47	0.44	0.45	0.48	0.52	0.56	0.59
Interest	4 months	0.44	0.66	0.84	0.90	0.88	0.87	1.09	1.37	1.96	2.58	2.47
S. Total		19.07	25.24	28.74	30.79	30.24	29.75	35.53	42.44	47.20	51.03	51.89
<u>Other Costs</u>												
Marketing		4.44	1.77	1.76	2.15	2.49	5.16	7.31	5.59	4.58	4.32	4.28
Transportation		0.41	0.44	0.60	0.67	0.71	0.76	0.80	1.04	1.42	1.61	1.54
Overhead		0.65	0.79	0.89	0.98	1.04	1.07	1.17	1.33	1.60	1.60	1.70
S. Total		5.50	3.00	3.25	3.80	4.24	6.99	9.28	7.96	7.60	7.53	7.52
Total costs		24.57	28.24	31.99	34.59	34.48	36.74	44.81	50.40	54.80	58.56	59.41

Table B.10. Costs per head of overwintering a 400 pound purchased calf to 658 pounds.

Cash Expenses	Resource Requirement	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
							Dollars					
Calf	400 lbs	158.14	186.86	89.00	108.88	119.36	132.60	221.04	298.40	269.18	231.24	240.64
Rye-Rye-grass pasture	0.5 acres	16.78	22.93	28.68	26.83	25.98	25.28	27.40	33.65	37.63	39.30	38.93
Bahia-Clover pasture	0.04 month	1.39	1.84	2.08	2.22	2.19	2.23	2.58	3.09	3.40	3.65	3.72
Fuel and maintenance	151 days	0.45	0.76	0.76	0.91	0.91	0.91	1.21	1.66	1.96	1.81	1.81
Medicine		1.29	1.46	1.96	2.13	1.92	1.80	1.84	1.96	2.13	2.28	2.40
Salt and minerals		0.63	0.71	0.96	1.04	0.94	0.88	0.90	0.96	1.04	1.11	1.17
Interest	5 months	6.02	7.20	4.25	5.06	5.34	6.04	13.12	15.89	16.54	17.93	17.27
S. Total		212.56	223.30	117.49	140.19	147.68	166.34	344.65	397.21	321.90	286.88	293.70
Other Costs												
Procurement ^a		1.21	1.24	0.80	0.97	1.04	1.17	2.04	2.42	2.29	2.22	2.24
Marketing		4.44	3.66	3.11	3.59	3.37	5.14	7.91	6.19	5.90	6.04	5.97
Transportation		0.41	0.44	0.60	0.67	0.71	0.76	0.80	1.04	1.42	1.61	1.54
Overhead		1.03	1.19	1.37	1.50	1.57	1.63	1.76	2.02	2.25	2.43	2.59
Labor		7.04	6.52	5.85	6.70	6.68	8.68	12.50	11.65	11.83	12.27	12.30
S. total		14.13	13.05	11.73	13.43	13.37	17.38	25.01	23.32	23.69	24.57	24.64
Total cost net of labor		219.70	229.83	123.37	146.92	154.37	175.04	357.16	408.88	333.76	299.18	306.04

^aIncludes procurement transportation.

Table B.11. Costs per head of producing a 450 pound fall calf.

Variable Cash Production Expenses	Resource Requirement	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
Dollars												
Rye-Rye/Grass pasture	0.5 acres/ cow-calf	16.78	22.93	28.68	26.83	25.98	25.28	27.40	33.65	37.63	39.30	38.93
Bahia-Clover pasture	1.2 acres/ cow-calf	37.78	46.56	61.08	64.56	60.06	60.96	70.20	87.12	94.44	102.54	104.16
Hay	0.60 T	24.00	32.40	33.00	30.00	38.40	33.00	31.80	31.80	40.80	42.00	47.50
Protein Supplement	1.85 cwt/cow	13.69	16.65	16.34	20.54	18.09	17.48	19.41	22.27	20.54	20.67	28.92
Salt and minerals	40 lbs	2.12	2.40	3.48	3.40	3.40	3.20	3.28	3.44	4.00	4.28	4.52
Veterinary and medicines		3.25	3.60	4.00	4.20	4.20	4.00	6.00	6.30	7.00	7.75	7.75
Repairs and maintenance		1.42	1.76	2.00	2.09	2.22	2.40	2.62	2.84	2.98	3.00	3.07
Machinery including pick-up		5.22	7.65	9.26	8.19	9.59	10.18	10.19	15.25	16.86	16.78	16.03
Labor	6 hours/cow	10.80	10.80	12.00	18.00	18.00	19.50	21.00	24.00	27.00	28.50	30.00
Miscellaneous	1.5%	1.55	2.00	3.79	2.40	2.43	2.35	2.56	3.05	3.37	3.55	3.77
Interest on cash expenses	10 months	6.15	9.10	12.13	12.17	12.33	11.91	13.94	17.15	24.66	31.98	31.83
S. Total net of labor		110.96	145.05	173.76	171.98	176.70	170.76	189.96	222.97	252.28	271.85	286.48
Other Expenses												
Fixed production costs												
Building and equipment		7.61	8.52	10.69	11.17	11.88	12.83	14.02	15.21	15.92	16.04	16.40
Machinery and pick-up		3.90	4.18	5.47	5.74	6.67	7.40	8.24	9.12	12.26	13.30	14.18
Replacement bull		5.00	4.15	4.23	4.24	4.20	5.63	11.07	10.40	10.00	12.00	11.38
S. Total		16.51	16.86	20.39	21.15	22.75	25.86	33.33	34.73	38.18	41.34	41.96

Table B.11.--continued.

Variable Cash Production Expenses	Resource Requirement	Dollars										
		1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
Taxes and insurance (2% of value of investment) ^e		3.01	3.69	4.20	4.38	4.66	5.04	5.57	6.02	6.29	6.33	6.46
Total variable cash production expenses, fixed production expenses, and taxes and insurance		<u>130.48</u>	<u>165.59</u>	<u>198.35</u>	<u>197.51</u>	<u>204.11</u>	<u>201.66</u>	<u>228.86</u>	<u>263.62</u>	<u>296.75</u>	<u>319.52</u>	<u>334.90</u>
Capital charges on investment		<u>1.34</u>	<u>1.59</u>	<u>1.82</u>	<u>1.74</u>	<u>1.79</u>	<u>2.28</u>	<u>3.57</u>	<u>4.47</u>	<u>5.69</u>	<u>6.16</u>	<u>6.02</u>
Total cost net of labor		131.82	167.18	200.17	199.25	205.90	203.94	232.43	268.09	302.44	325.68	340.92

^aThe base for the 1973 price estimate was the 1974 price. The 1977 price was used as the base for the 1975, 1978 and 1979 price estimates. The 1981 price was the base for the 1980, 1982 and 1983 estimates. All estimates were computed from the base price and the Agricultural Chemicals Price Index, U.S. Department of Agriculture, Agricultural Prices, Annual Summary, June 1984.

^bTwo visits by the veterinarian per year, plus insecticides, worming, vaccination and growth stimulants (1979-1983).

^cIndexed from 1982 cost estimates by Eason (1982), of \$3.00 per head.

^dBased upon Simpson et al. (1982), 1.4 tractor hours and 45 miles for the pick-up.

^eIncludes cows, bulls and replacement heifers.

Table B.12. Costs per head of producing a 350 pound fall calf.

Variable Cash Production Expenses	Resource Requirement	Dollars										
		1973	1974	1975	1975	1977	1978	1979	1980	1981	1982	1983
Rye-Ryegrass pasture	0.5 acres/ cow-calf	16.78	22.93	28.68	26.83	25.98	25.28	27.40	33.65	37.63	39.30	38.93
Bahia pasture	1.0 acres/ cow-calf	30.65	38.80	50.90	53.80	50.05	50.80	58.50	72.60	78.70	85.45	86.80
Hay	0.65 T	26.00	35.10	35.75	32.50	41.60	35.75	34.45	34.45	44.20	45.50	51.46
Protein supplement	2.35 cwt/cow	17.39	17.86	20.75	26.09	22.98	22.21	24.65	28.29	26.09	26.25	36.73
Salt and minerals ^a	40 lbs	2.12	2.40	3.48	3.40	3.40	3.20	3.28	3.44	4.00	4.28	4.52
Veterinary and medicine ^b		3.25	3.60	4.00	4.20	4.20	4.00	6.00	6.30	7.00	7.75	7.75
Repairs and maintenance ^c		1.42	1.76	2.00	2.09	2.22	2.40	2.62	2.84	2.98	3.00	3.07
Machinery including pick-up ^d		5.22	7.65	9.26	8.19	9.59	10.18	10.19	15.25	16.86	16.78	16.03
Labor	6 hours/cow	10.80	10.80	12.00	18.00	18.00	19.50	21.00	24.00	27.00	28.50	30.00
Miscellaneous	1.5%	1.54	1.95	2.32	2.36	2.40	2.31	2.51	2.50	3.26	3.43	3.68
Interest on cash expenses		4.88	7.05	9.43	9.57	9.75	9.37	10.75	11.29	19.13	24.72	24.90
S. Total net of labor	8 months	109.25	139.10	166.57	169.03	172.17	165.50	180.35	180.61	239.85	256.46	273.87
Other Expenses												
Fixed production costs												
Building and equipment		7.61	8.52	10.69	11.17	11.88	12.83	14.02	15.21	15.92	16.04	16.40
Machinery and pick-up		3.90	4.18	5.47	5.74	6.67	7.40	8.24	9.12	12.26	13.30	14.18
Replacement bull		5.00	4.15	4.23	4.24	4.20	5.63	11.07	10.40	10.00	12.00	11.38
S. Total		16.51	16.85	20.39	21.15	22.75	25.86	33.33	34.73	38.18	41.34	41.76

Table B.12.--continued.

Variable Cash Production Expenses	Resource Requirement	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
Dollars												
Taxes and insurance (2% of value of investment) ^e		3.01	3.69	4.20	4.38	4.66	5.04	5.57	6.02	6.29	6.33	6.46
Total variable cash production expenses, fixed production expenses, and taxes and insurance		128.77	159.64	191.16	194.56	199.58	196.40	219.25	221.36	284.32	304.13	322.09
Capital charges on investment		1.34	1.59	1.82	1.74	1.79	2.28	3.57	4.47	5.69	6.16	6.02
Total costs net of labor		130.11	161.23	192.98	196.30	201.37	198.68	222.82	225.83	290.01	310.29	328.11

^aThe base for the 1973 price estimate was the 1974 price. The 1977 price was used as the base price for the 1975, 1978 and 1979 price estimates. The 1981 price was the base for the 1980, 1982 and 1983 estimates. All estimates were computed from the base price and the Agricultural Chemicals Price Index, U.S. Department of Agriculture, Agricultural Prices, Annual Summary, June 1984.

^bTwo visits by the veterinarian per year, plus insecticides, worming, vaccination and growth stimulants (1979-1983).

^cIndexed from 1982 cost estimated by Eason (1982), of \$3.00 per head.

^dBased upon Simpson et al. (1982), 1.4 tractor hours and 45 miles for the pick-up.

^eIncludes cows, bulls and replacement helpers.

Table B.13. Costs per head of producing a 450 pound spring calf.

Variable Cash Production Expenses	Resource Requirement	Dollars										
		1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
Rye-Ryegrass pasture	0.5 acres	16.78	22.93	28.68	26.83	25.98	25.28	27.40	33.65	37.63	39.30	38.93
Bahia-Clover pasture	1.2 acres	37.78	45.56	61.08	64.56	60.06	60.96	70.20	87.12	94.44	102.54	104.16
Hay	0.9 cwt	24.00	32.40	33.00	30.00	38.40	33.00	31.80	31.80	40.80	42.00	47.50
Protein supplement	0.9 cwt	6.03	6.84	9.18	9.99	9.00	8.46	8.64	9.18	9.99	20.80	11.25
Salt and minerals	40 lbs	2.12	2.40	3.48	3.40	3.40	3.20	3.28	3.44	4.00	4.28	4.52
Veterinary and medicine		3.25	3.60	4.00	4.20	4.20	4.00	6.00	6.30	7.00	7.75	7.75
Repairs and maintenance		1.42	1.76	2.00	2.09	2.22	2.40	2.62	2.84	2.98	3.00	3.07
Machinery and pick-up		5.22	7.65	9.26	8.19	9.59	10.18	10.19	15.25	16.86	16.78	16.03
Labor	6 hours	10.80	10.80	12.00	18.00	18.00	19.50	21.00	24.00	27.00	28.50	30.00
Miscellaneous	1.5%	1.45	1.86	2.26	2.24	2.29	2.21	2.40	2.84	3.21	3.40	3.50
Interest on cash expenses	10 months	5.72	8.40	11.47	11.36	11.64	11.23	12.87	16.04	23.50	30.65	29.59
S. Total net of labor		103.77	134.40	164.41	162.86	166.78	160.92	175.40	208.46	240.40	260.49	266.30
<u>Other Expenses</u>												
Fixed production costs												
Building and equipment		7.61	8.52	10.69	11.17	11.88	12.83	14.02	15.21	15.92	16.04	16.40
Machinery and pick-up		3.90	4.18	5.47	5.74	6.67	7.40	8.24	9.12	12.26	13.30	14.18
Replacement bull		5.00	4.15	4.23	4.24	4.20	5.63	11.07	10.40	10.00	12.00	11.38
S. Total		16.51	16.85	20.39	21.15	22.75	25.86	33.33	34.73	38.18	41.34	41.96

Table B.13.--continued.

Variable Cash Production Expenses	Resource Requirement	Dollars										
		1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
Taxes and insurance (2% of value of investment)		3.01	3.69	4.20	4.38	4.66	5.04	5.57	6.02	6.29	6.33	6.46
Total variable cash production expenses, fixed production expenses, and taxes and insurance		<u>123.29</u>	<u>154.94</u>	<u>189.00</u>	<u>188.39</u>	<u>194.19</u>	<u>191.82</u>	<u>214.30</u>	<u>249.21</u>	<u>284.87</u>	<u>308.16</u>	<u>314.72</u>
Capital charges on investment		<u>1.34</u>	<u>1.59</u>	<u>1.82</u>	<u>1.74</u>	<u>1.79</u>	<u>2.28</u>	<u>3.57</u>	<u>4.47</u>	<u>5.69</u>	<u>6.16</u>	<u>6.02</u>
Total cost net of labor		124.63	156.53	190.82	190.13	195.98	194.10	217.87	253.68	290.56	314.32	320.74

^aThe base for the 1973 price estimate was the 1974 price. The 1977 price was used as the base price for the 1975, 1978 and 1979 price estimates. The 1981 price was the base for the 1980, 1982 and 1983 estimates. All estimates were computed from the base price and the Agricultural Chemicals Price Index, U.S. Department of Agriculture, Agricultural Prices, Annual Summary, June 1984.

^bTwo visits by the veterinarian per year, plus insecticides, worming, vaccination and growth stimulants (1979-1983).

^cIndexed from 1982 cost estimated by Eason (1982), of \$3.00 per head.

^dBased upon Simpson et al. (1982), 1.4 tractor hours and 45 miles for the pick-up.

^eIncludes cows, bulls and replacement heifers.

Table B.14. Costs per head of producing a 350 pound spring calf.

Variable Cash Production Expenses	Resource Requirement	Dollars										
		1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
Rye-Ryegrass pasture	0.5 acres/ cow-calf	16.78	22.93	28.68	26.83	25.98	25.28	27.40	33.65	37.63	39.30	38.93
Bahia-Clover pasture	1.0 acres/ cow-calf	30.65	38.80	50.90	53.80	50.05	50.80	58.50	72.60	78.70	85.45	86.80
Hay	0.5 T	20.00	27.00	27.50	25.00	32.00	27.50	26.50	26.50	34.00	35.00	39.59
Protein supplement	20 lbs	1.34	1.52	2.04	2.22	2.01	1.88	1.92	2.04	2.22	2.40	2.50
Salt and minerals	40 lbs	2.12	2.40	3.48	3.40	3.40	3.20	3.28	3.44	4.00	4.28	4.52
Veterinary and medicine		3.25	3.60	4.00	4.20	4.20	4.00	6.00	6.30	7.00	7.75	7.75
Repairs and maintenance		1.42	1.76	2.00	2.09	2.22	2.40	2.62	2.84	2.98	3.00	3.07
Machinery and pick-up		5.22	7.65	9.26	8.19	9.59	10.18	10.19	15.25	16.86	16.78	16.03
Labor	6 hours/cow	10.80	10.80	12.00	18.00	18.00	19.50	21.00	24.00	27.00	28.50	30.00
Miscellaneous	1.5%	1.21	1.59	1.89	1.89	1.91	1.88	2.05	2.44	2.75	2.91	2.99
Interest on cash expenses	8 months	<u>3.83</u>	<u>5.72</u>	<u>7.66</u>	<u>7.66</u>	<u>7.77</u>	<u>7.63</u>	<u>8.31</u>	<u>11.00</u>	<u>16.13</u>	<u>21.00</u>	<u>20.22</u>
S. Total net of labor		85.82	112.97	135.37	135.27	137.30	134.75	146.76	176.06	202.27	217.87	222.40
<u>Other Expenses</u>												
Fixed production costs												
Building and equipment		7.61	8.52	10.69	11.17	11.88	12.83	14.02	15.21	15.92	16.04	16.40
Machinery and pick-up		3.90	4.18	5.47	5.74	6.67	7.40	8.24	9.12	12.26	13.30	14.18
Replacement bull		<u>5.00</u>	<u>4.15</u>	<u>4.23</u>	<u>4.24</u>	<u>4.20</u>	<u>5.63</u>	<u>11.07</u>	<u>10.40</u>	<u>10.00</u>	<u>12.00</u>	<u>11.38</u>
S. Total		16.51	16.85	20.39	21.15	22.75	25.86	33.33	34.73	38.18	41.34	41.96

Table B.14.--continued.

Variable Cash Production Expenses	Resource Requirement	Dollars										
		1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
Taxes and Insurance (2% of value of investment)		3.01	3.69	4.20	4.38	4.66	5.04	5.57	6.02	6.29	6.33	6.46
Total variable cash production expenses, fixed production expenses, and taxes and insurance		105.34	133.51	159.96	160.80	164.71	165.65	185.66	216.81	246.74	265.54	270.82
Capital charges on investment		1.34	1.59	1.82	1.74	1.79	2.28	3.57	4.47	5.69	6.16	6.02
Total cost net of labor		106.68	135.10	161.78	162.54	166.50	168.03	189.23	221.28	252.43	271.70	276.84

^aThe base for the 1973 price estimate was the 1974 price. The 1977 price was used as the base price for the 1975, 1978 and 1979 price estimates. The 1981 price was the base for the 1980, 1982 and 1983 estimates. All estimates were computed from the base price and the Agricultural Chemicals Price Index, U.S. Department of Agriculture, Agricultural Prices, Annual Summary, June 1984.

^bTwo visits by the veterinarian per year, plus insecticides, worming, vaccination and growth stimulants (1979-1983).

^cIndexed from 1982 cost estimated by Eason (1982), of \$3.00 per head.

^dBased upon Simpson et al. (1982), 1.4 tractor hours and 45 miles for the pick-up.

^eIncludes cows, bulls and replacement heifers.

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David Zimet was born in New York in 1948 and obtained a B.S. in general agriculture from Cornell University in 1969. After serving in the Peace Corps he joined the M.S. program at the University of Florida. His M.S. thesis was named the best thesis of the Food and Resource Economics Department in 1974, the year he was awarded his M.S. After working overseas for several years he returned to the University of Florida to earn a Ph.D. He started working as a research associate for the Food and Resource Economics Department in January, 1983. David is married to Ann Soffes Zimet, Ph.D., and has two sons, Zacharia and Nathaniel.

I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.

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